THURSDAY, DECEMBER 16, 1915.

INDUSTRIAL RESEARCH LABORATORIES.

THE application of science to industry is a subject which the war has brought to the forefront in the most striking way possible; and it is beginning to be understood how essential to industrial development is scientific research, whether carried on purely with the motive of increasing natural knowledge, or in laboratories where financially profitable solutions of practical problems are the chief aims.

One of the most interesting characteristics of the development of industrial organisations during recent years has been the establishment of industrial research laboratories. A laboratory for the testing of the materials employed, and of the finished products of a manufacturing firm, is an essential part of every modern works. The newer laboratories, however, show that manufacturers are realising the necessity for scientific research in those branches of science with which their industry is most closely connected. They realise that it is not enough to ensure that the apparatus and machinery that is manufactured is up to standard, and to effect those minor improvements in detail which become evident from careful and systematic tests; but that it is necessary for the advancement of their work to carry out scientific investigations. A great deal can be said in favour of this work being done by central State institutions adequately equipped and provided with an efficient staff for carrying out such researches as may be desired by the manufacturers. Such laboratories exist at present in this and other countries.

The work of the National Physical Laboratory is known to all, and the value of what has been done in making tests and measurements on all kinds of material and apparatus is universally recognised. In America the Bureau of Standards is now established on a scale princely in comparison with our laboratory at Teddington. In Germany the "Reichsanstalt" and the "Versuchsanstalt," for investigating the properties of materials used in engineering structures, have proved of enormous value. The engineering and scientific laboratories of the universities and higher technical schools have also contributed no small share to the increase of our knowledge of facts essential to the advancement of industry.

In such investigations as those on the properties of materials, standardisation of specifications, and work of a character which necessitates strict impartiality as between different manufacturers, there is no doubt that State institutions provide the only practical method of doing what is required. For experiments on a large scale where it is necessary to use the manufacturing facilities of a large factory to the utmost, for example, in the development of new types of engine or of improved constructional work, it seems equally clear that the manufacturer is the only person who can undertake the research work that may be required effectively.

The war has already led to a more intimate association between the scientific worker and the manufacturer than has ever existed before in this country; a result which has been due very largely to the overwhelming evidence which Germany has provided of the effects such co-operation has been able to produce on her industries.

To carry out researches in a factory requires the service of scientifically trained men who will undertake investigations in a scientific way, and will co-ordinate the results with the least possible expenditure of time and energy. If time is to be saved by eliminating suggested improvements which are not based on sound scientific principles, it is essential that the work should be done by people who have a thorough groundwork of scientific knowledge. They need not necessarily be highly skilled in the technique of the process they are investigating, though a good knowledge of applied science is an invaluable asset to such an investigator.

Most manufacturers will acknowledge that it is to scientifically trained men working in well-equipped research laboratories that the greater part of industrial progress is due. Such men must be endowed with a critical scientific faculty and be able to avoid the pitfalls that trap the untrained inventor. In an article by Mr. Little in the *Journal of Industrial and Engineering Chemistry*, some facts are given about the progress of these laboratories in the United States. He cites the famous Edison laboratories as an example of what has been done in this direction. The Eastman Kodak Company has large laboratories for purely scientific investigations. The Du Pont Powder Company employs 250 trained chemists with laboratories spread over sixty acres of ground. But perhaps the most interesting example of what is being done in this direction by large firms in America is the research laboratory of the General Electric Company of Schenectady.

This laboratory started on quite a small scale about fourteen years ago. It now occupies a

seven-storey building with a staff of 150 researchers. It possesses a good library in which the chief scientific publications are available, an elaborately equipped workshop and experimental rooms for scientific investigations. A considerable portion of its work is connected with the testing of insulating material for electrical machinery. Other subjects of study are the mechanical and electrical properties of alloys both for magnetic and resistance work. Experimental investigations are undertaken in connection with incandescent lamps. The experiments made there were the basis of the new gas-filled tungsten lamp. The scientific groundwork of the processes of lamp manufacture in all its branches is thoroughly examined. One room is devoted to phenomena occurring in very high vacuum. The electron emission from a hot tungsten filament in a vacuum, so high that there is very little ionisation, has been studied and has been utilised in the Coolidge X-ray tube and in the development of a high voltage rectifier. Another branch of study is that of the high frequency phenomena which find their application in wireless telegraph transmission, and for this purpose a wireless antenna for experimental purposes has been erected. In an article by Mr. L. A. Hawkins describing the laboratory, he states that:—

"The laboratory is continuously conducting researches of a purely scientific nature and publishing the results, to endeavour to contribute its share to the progress of scientific thought. . . . These investigations may be initiated because of their scientific interest without any definite practical object in view, but . . . every marked advance in science sooner or later, directly or indirectly, has resulted in important effects on industry, and these laboratory investigations have certainly nearly always had practical results. . . . It should not be supposed, however, that all the important achievements of the laboratory have been thus brought about. Many of them were the result of persistent and resourceful effort directed from the beginning towards a perfectly definite goal. . . . Even in those cases where unforeseen practical results are made possible by the new insight into fundamentals, gained from purely scientific research, they seldom first appear in fully developed form, like Athena sprung from the brain of Zeus, but much work, inventive and experimental, is usually necessary before that end is reached."

It would be impossible to express more clearly than has been done in these paragraphs the point of view which scientific men have been urging for many years past, and it is a hopeful sign that those responsible for such a large industrial undertaking as the General Electric Company should have come to the conclusion that purely scientific investigation is one of the necessary conditions of progressive development, and should have acted so practically as a result of that belief.

The industrial conditions existing in this country hitherto have made it almost impossible to establish research laboratories in connection with many engineering works. Possibly this may have been due to a failure on the part of those concerned to recognise the importance of industrial research. Possibly, and more probably, it has been due to the financial conditions under which many British engineering firms have had to work, and to the insecurity of the markets which they have had to supply. If neglect of research is the true explanation of our backwardness, the excuse will hold no longer, as the war has proved, as nothing else could have done, what remarkable productive results may be obtained from a scientifically organised industry.

WIRELESS TELEGRAPHY AND TIME SIGNALS.

(1) *The Wireless Telegraphist's Pocket Book of Notes, Formulae, and Calculations.* By Prof. J. A. Fleming. Pp. xii + 347. (London: Wireless Press, Ltd., 1915.) Price 6*s.* net.

(2) *Wireless Time Signals: Radio-telegraphic Time and Weather Signals Transmitted from the Eiffel Tower, and their Reception.* Issued by the Paris Bureau of Longitudes. Pp. ix + 133. (London: E. and F. N. Spon, Ltd., 1915.) Price 3*s.* 6*d.* net.

(1) THIS book, though of more than three hundred pages, is of a size that can go into a moderately large pocket, and contains, in virtue of the clear and close printing, a large amount of information. To those who are familiar with Prof. Fleming's large treatise on electric-wave telegraphy the present volume may be briefly described by saying that it is for the main part a series of notes carefully selected from that work, together with matter from recent papers by the author, and with a number of mathematical tables.

In style and contents the book is a decided departure from other "pocket books" dealing with engineering subjects, for it is devoted rather to the abstract theory of its subject than to the workaday aspects. Moreover, many of the formulæ and equations are developed in full logical form, and not merely thrown down before the reader in their final shape, ready for practical applications.

The first chapter may be regarded as a summary of those parts of mathematics and mathematical physics which are applied to wireless telegraph problems in the author's larger treatise. There is a brief exposition of differential and integral calculus, of differential equations, of the theory of the Argand diagram, and of vector analysis, culminating in an explanation of the more mathematical aspects of divergence, curl, and vector potential, and in the derivation of Poisson's equation and Stokes's theorem. Later this theory is applied in the orthodox way to the formation of Maxwell's equations and to the solution in the standard manner of the Hertz oscillator problem. The second chapter is more physical than the first, and deals with the important subjects of units and dimensions.

Chapters iii. to vi. discuss the laboratory physics of wireless telegraphy, attention being paid especially to the derivation of the formulæ used in the electrical laboratory. For example, there is a good and fairly full account of the theory of certain bridge methods of measuring inductance and capacity. Chapters ix. and x. deal with the principles underlying the production of electric waves, and contain the principal formulæ for the radiation from antennæ. Similarly the next chapter, on the reception of signals, is devoted largely to principles, though containing some useful pages occupied with brief descriptions of various detectors. From the list of detectors the modern forms of the vacuum valve detector and relay are all missing, although these are playing so large a *rôle* in recent long-distance triumphs in wireless telegraphy and telephony. Chapter xi. begins the practical portion of the work. In it are given the Morse code, some hints on the management of storage cells, a couple of pages on the management of wireless telegraph apparatus, and a glossary of terms. Chapter xii. concludes the book with about fifty pages of the usual mathematical tables and eight pages of tables of physical constants. The mathematical tables are very beautifully printed, and contain some improvements designed to make reference rapid and easy.

The most permanent impression left by the book on the mind of the reviewer is that the author appears to entertain a very high opinion of the intellectual equipment of the wireless telegraphist and of his ambition to breathe the rarest atmosphere of the subject. In all probability the book will receive a warmer welcome from the advanced students of electro-technics in our colleges than from the class it is ostensibly written for.

(2) This little book is a translation of one issued two or three years ago by the Paris Bureau of Longitudes for enabling French nagivators, clockmakers, and others requiring accurate time, to make full use of the excellent series of radiotelegraphic time signals sent daily from the Eiffel Tower station. Since the Paris station is only one of a projected international chain of time stations, such a book as this is, or will be, useful in other countries.

The work begins with a clear description of the apparatus needed by a person who wishes to receive the time signals; several types of apparatus are, in fact, described, beginning with the very simplest and closing with a fairly elaborate plant. It will be difficult to find anywhere an explanation more helpful to the novice than this. Then follows an account of the kinds of time signals emitted from the Eiffel Tower, which include morning and evening sets of signals intended for navigators and horologists, and also scientific signals which give, by an application of the method of coincidences, the time accurate to about 1/100 second.

Of course, the war has put much of the work of the Eiffel station out of joint; for instance, the meteorological signals described in this book are not now transmitted as before, but no hint of this fact is given in the book, which, though dated 1915, speaks as if everything were proceeding normally everywhere. This failure to take account of the effects of the war on wireless telegraph matters appears even in the translators' appendices, in one of which it is stated that English weather reports are issued daily by the Admiralty from Whitehall and Cleethorpes. The writer of this review cannot affirm with finality that such reports are not issued; no private individual is now allowed to possess "wireless" apparatus to test the matter—but it is unlikely that meteorological reports are sent broadcast at this period. This fault is apparently the only fault of the work, and it is here pointed out for the sake of historical accuracy.

THE STEAM ENGINE.

Steam Power. By Prof. W. E. Dalby. Pp. xvi +760. (London: Edward Arnold, 1915.) 21*s.* net.

IN this volume we have the most complete, the most scientifically correct, and the most up-to-date treatment of the problem of the generation of steam and its utilisation for power purposes which has ever been put at the disposal of the engineer and the designer of power plants.

Although Sir J. A. Ewing in the latest edition

of his book on the steam engine had accepted the characteristic equation of Callendar and had utilised the steam tables derived from it by Mollier, and had thus directed the attention of the British engineering world to Callendar's researches, it is to be feared that the majority of our engineers were still ignorant of and oblivious to the epoch-making character of Prof. Callendar's researches and his work in the field of thermodynamics.

Prof. Dalby has made it impossible for anyone in the future to ignore these researches. In chapter iii., on the motive-power circuit-thermodynamics, in sections 47 to 49 Callendar's characteristic equation of steam is dealt with in a clear and concise fashion; and the whole of the steam tables in the appendix have been calculated by Prof. Callendar himself from the expressions given in this chapter. In chapter iv. the sections dealing with the so-called "missing quantity" are practically based upon the researches of Callendar and Nicolson (by a slip in the preface an account of these researches is stated to be incorporated in chapter v.), and lastly Prof. Callendar's work on the theory of the flow of steam through nozzles is made free use of in chapter xi., which deals with this important branch of the subject, of such vital importance in the design of steam turbines. We have indicated enough to show how largely the author has drawn upon the rich stores of theory and experimental results which Prof. Callendar has placed in recent years at the disposal of engineers.

Following Sir J. A. Ewing, the author has abandoned the Fahrenheit and adopted the Centigrade scale; modern research is always expressed in terms of this latter scale, and it is certainly high time that British and American engineers discarded for ever the Fahrenheit scale, which introduces needless complications, and has nothing to commend it; for commercial reasons alone it would be a great advantage to engine-builders and others to come into line with the rest of the world and to adopt the Centigrade scale. It may be a difficult matter to introduce in its entirety the metric system, though we have little doubt that sooner or later such a change must be made, but it would surely be an easy matter to pass an Act enforcing the use, after a given interval of time, of the Centigrade thermometer and making it illegal to manufacture any longer Fahrenheit thermometers. The Meteorological Department has recently made a valuable step forward in deciding that in future rainfall records shall be given in millimetres. Why not go a step further and publish all their temperature records in the Centigrade scale? Were the Department to take this step the public would soon fall into line, and in a short time everyone would as readily think in Centigrade units as they do now in Fahrenheit units. We warmly congratulate the author for the decision he came to in this matter; for the time being it is necessary, if we use the Centigrade scale, to adopt a somewhat unusual heat unit—the lb.-calorie, but such a unit is inevitable so long as we retain the pound as the unit of weight.

Prof. Dalby has for some time been in the front rank of those workers who have specialised in that section of thermodynamics which deals with the problem of the steam locomotive, and he has drawn freely upon his published researches for much of the matter contained in chapter viii., which deals with the motion of a train and the rate at which energy must be spent to produce, to maintain, and to destroy it. This chapter will prove invaluable to the designers of locomotives; it is largely the result of original work, and the problems to be solved have been attacked in a strikingly novel manner. The validity of the author's methods has been confirmed by examination of the published results of elaborate tests of the performances of locomotives carried out in the United States. It is well known that Prof. Dalby has organised a highly successful post-graduate course in railway engineering at the Imperial College of Science, South Kensington, and this chapter is a striking testimony to the thoroughness with which he is attacking the problems which will have to be faced if any radical improvement in the thermal efficiency of the steam locomotive is to be obtained in the near future.

Two other chapters which will be specially useful to the drawing office are those dealing with the balancing of engines, and valves and valve-gear diagrams, treated, of course, in a more condensed fashion than in the author's well-known text-books on these two branches of engine design, but still in a sufficiently full and complete form for the engineer who aims at acquiring a sound knowledge of the principles upon which the successful design of engines must be based.

The last chapter deals with steam turbines, and we think Prof. Dalby has in this chapter produced the best account we have ever read of this class of steam generators, both from the point of theory and of actual design, and it says much for his methods that he has been able to do this in some seventy-five pages.

If we have any criticism to offer on this book, it is in the form of a suggestion that in any reissue the book should be broken up into two volumes. The present volume contains 760 pp.,

and is really too cumbersome and heavy for convenient use. If chapters i. to vi. and chapter xi. formed one volume, with the steam tables as an appendix, the other chapters would fit well into a second volume.

In conclusion, we offer our warm congratulations to the author. He has achieved a great task; this book is a testimony to his powers as an original worker, and to the wide grasp he has obtained of the whole field of work covered by it. We would commend a careful study of the book to those, only too numerous, detractors of the work achieved by British men of science and practical engineers. They will find ample testimony that in this field of human activity the British workers easily hold a foremost place.

T. H. B.

MATHEMATICAL TEXT-BOOKS.

(1) *Plane Geometry*. By G. St. L. Carson and Prof. D. E. Smith. Part i., pp. vi+266. Part ii., pp. vi+259–482. (London and Boston: Ginn and Co., 1914–15.) Price 2*s*. 6*d*. each part.

(2) *Elements of Algebra*. By G. St. L. Carson and Prof. D. E. Smith. Part ii., pp. v+538. (London and Boston: Ginn and Co., 1915.) Price 2*s*. 6*d*.

(3) *Contributions to the Founding of the Theory of Transfinite Numbers*. By G. Cantor. Translated by P. E. B. Jourdain. Pp. ix+211. (Chicago and London: The Open Court Publishing Co., 1915.) Price 3*s*. 6*d*. net.

(4) *A Text-book on Practical Mathematics for Advanced Technical Students*. By H. L. Mann, Pp. xii+487. (London: Longmans, Green and Co., 1915.) Price 7*s*. 6*d*. net.

(5) *Descriptive Geometry*. By H. W. Miller. 3rd edition. Pp. 149. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1915.) Price 6*s*. 6*d*. net.

(1) MANY attempts are now being made to formulate a system of geometry suitable to the immature minds of schoolboys, which will on one hand develop their reasoning faculties by some kind of logical training, and on the other by a sufficiency of practical work clarify their ideas as to the concepts which form the basis of the subject.

It is unfortunately true that as yet no general agreement has been obtained, or any course determined which is not open to formidable attacks from one school of thought or another. Time alone will bring about consensus of opinion in a controversy that has raged since the time when Lewis Carroll wrote his "Euclid and his Modern Rivals"; and educational opinion will gradually solidify by the action of those teachers and writers who are attempting to express the results of their personal experience.

If for no other reason, we hope that this volume will receive the serious consideration it merits; for it offers, not indeed a final, but certainly a valuable contribution to these issues. It would be beyond the scope of this notice to examine in any detail the course followed; and it is detailed examination alone that justifies the passing of any judgment. The authors have had extensive experience in the matters of which they write, and the views they have formed are the product of a genuine knowledge of the needs and capacities of junior students and of those psychological considerations to which educationists are now attaching due importance.

(2) The first part of this text-book has already been noticed in these columns; the second part, written on similar lines, carries the student as far as progressions and the binomial theorem for a positive integral index. We notice with regret that the section on graphs includes the tracing of the ellipse $4x^2+9y^2=288$; such work should, in our opinion, be relegated to co-ordinate geometry proper; we think also that examples on the greatest term in a binomial expansion, although sanctioned by tradition, might well be omitted from the ordinary algebra course. But, except for a few minor points such as these, the character of the book appears to us excellent, and we shall expect to see it hold its own in the strenuous competition that every text-book on elementary algebra has now to face.

(3) This volume contains the two classical memoirs on transfinite cardinal and ordinal numbers which Prof. Cantor contributed to the *Mathematische Annalen* in 1895 and 1897. They are prefaced by a long introduction (more than 80 pages) by Mr. Jourdain, in which he traces the growth of the theory of functions through the nineteenth century, with special reference to the work of Cantor and Weierstrass; the concluding pages of the book contain some notes on modern developments.

This introduction will undoubtedly prove of great value to English students and teachers; its admirable summary of the progress of ideas will smooth their pathway and assist and encourage them to study that modern work to which the author has himself already furnished substantial contributions.

(4) Although the first few chapters are devoted to such algebra, trigonometry and geometry as technical students are likely to require, the main purpose of this book is to provide a suitable

calculus course for engineers. The preliminary work appears to have been selected solely with this end in view.

It is rather a formidable-looking volume, containing nearly 500 pages; and it would be more readable if there was some variation in the type (in itself very good) employed. There are many signs of individuality in the methods of treatment and in the choice of subject-matter; the examples are particularly stimulating, and on this account alone teachers would do well to examine it. The sections on periodic functions and harmonic analysis deserve a special word of praise.

(5) This small text-book contains in a compact form the elements of practical drawing. The author writes from the point of view of one who has realised from industrial work the importance of accuracy in the workshops, and he insists throughout on the need of close attention to conventional notation and lucidity of expression. His diagrams are clear, and his explanations are couched in simple language.

For most students descriptive geometry is not an easy subject; it requires a power of visualising, which comes only after long perseverance and practice. Such a book as this seems to us to give as much assistance to the student as he can receive from outside; a grasp of the subject can only be obtained by his own diligence.

OUR BOOKSHELF.

La Radiologie de Guerre. Manuel Pratique du Manipulateur Radiologiste. By G. Massiot and Biquard. Pp. viii+224. (Paris: A. Maloine et Fils, 1915.) Price 3.50 francs.

A NEW impulse has been given by the war to those who desire to say over again what has been often and well set out already in text-books dealing with the practical applications of X-rays. Nevertheless, it must be admitted that extraordinary inventive effort has been called for of late regarding the design of new apparatus to meet special and unusual conditions; and, in so far as a new book on the subject deals conscientiously with this fresh phase, it should prove useful in practice.

The work under review suffers somewhat from the defect that the authors are concerned with the appliances designed and made by one firm only. But if in one respect the book has the limitations of an elaborated trade catalogue, it also has the great merit of clearness and simplicity. It contains a large amount of general information relating to X-ray technique which should not only be invaluable to the beginner, but serve also as a guide to all who have to organise X-ray departments for war purposes. For instance, the device for the wet racking of plates described on page 136, at first sight a small matter, assumes importance when many negatives have to be developed and examined rapidly. The effectiveness of the method recommended has, in fact, been proved at one of the military hospitals in this country, where it has been adopted since the outbreak of war and where sometimes 200 plates have to be dealt with in a day.

The book is full of useful detail of this sort, and more than one hundred pages are devoted to the question of the localisation of imbedded foreign bodies. The whole elementary ground of practical radiography is fairly covered, although no mention is made of stomach examinations and the technique of what may be called the "higher X-ray diagnosis." There are illustrations of folding couches, portable X-ray outfits, and so on, as well as ambulances that are complete radiographic departments on wheels.

Within the limits stated in the early part of this notice the book may be thoroughly recommended. C. E. S. P.

Laboratory Manual of Horticulture. By Prof. G. W. Hood. Pp. vi+234. (Boston and London: Ginn and Co., 1915.) Price 4*s.* 6*d.*

A COURSE in horticulture is by no means easy to devise, but it is certain that so far as the craft of the horticulturist is concerned the best place to learn it is in the garden, the potting-shed, and the frame-yard: these must constitute the laboratory. Hand-in-hand with training there should go work in botany, especially in vegetable physiology, in elementary chemistry, and physics, with the double object of inculcating scientific method (which should not be ignored in the garden) and of education in a knowledge of how plants grow.

Judged by this standard this "Laboratory Manual of Horticulture" falls lamentably short. It consists largely of observations on buds, corms, and fruits, and of experimental exercises with seeds, all of which fall into the realm of horticultural botany, and of exercises on making cuttings, grafts, buds, grafting-wax, fungicides and insecticides. It is intended as a general course in horticulture, but is really a series of exercises which have a more or less direct bearing upon practical plant-growing. It is true that it is recommended that after fundamental principles are mastered practice should be given in pruning and spraying, but even if this is done, a course which does not include tillage operations, potting, seed-sowing, planting, propagation (apart from the mere making of cuttings, etc.), watering, heating, ventilation, pollination, etc., cannot properly be called a course in horticulture.

After all, it is mainly with the title that we quarrel. The book cannot fail to prove suggestive to the teacher, or the working of the exercises profitable to the taught. The exercises are interleaved with blank pages for the student's notes and report, but we do not quite like the temptation to "copy" which the illustrations afford when directions are given to draw something. F. J. C.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Pre-Columbian Representations of the Elephant in America.

WHEN I wrote my letter on this subject to NATURE (November 25, p. 340) I was not aware of the fact that another interpretation of the Copan elephants was being seriously adopted in America. The admission of the proboscidean nature of the sculptures in question would place those who indulge in speculations as to the wholly indigenous origin and local evolution of the pre-Columbian civilisation of America in so critical a dilemma that from time to time efforts have been made to discredit the obvious view of regarding them as elephants. In my previous letter I directed attention to the attempts which had been made to convert them into tapirs or tortoises. Certain American ethnologists are now suggesting that the Copan reliefs in question were really intended to represent *blue macaws*!

Ludicrous as this suggestion (Parry, 1893; Gordon, 1909; Tozzer and Allen, 1910; and Spinden, "A Study of Maya Art," Memoirs of the Peabody Museum, 1913, p. 79) may seem to those who examine the features of the unmistakable elephant, which I reproduced in my previous letter, the arguments in support of it are not nearly so lacking in cogency as those with which I have already dealt.

For if the macaw-hypothesis were admitted, it would help to explain the positions of the nostril and eye, the origin of the geometrical pattern around the eye, and, in a vague manner, the presence and form of the trunk (see Gordon, Putnam Anniversary Volume, 1909, pp. 193–95). At Copan there is a beautifully modelled and very realistic representation of the macaw. But the very excellence of the portrayal of the macaw is an argument against the contention that the proboscidean animals can also be meant to be pictures of that bird, even in a conventionalised and extremely modified form. When the American artists set about conventionalising natural objects, an occupation at which they were past-masters, their methods were vastly different from those which such a hypothesis demands. Moreover, the accurate representation of the Indian elephant's profile, its trunk, tusk, and lower lip, the form of its ear, as well as the turbaned rider and his implement, no less than the distinctively Hindu artistic feeling in the modelling, are entirely fatal to the macaw-hypothesis.

The representation of a man sitting upon the head is as wholly inappropriate if the beast of burden is a macaw, as it would be in the case of a tapir or a tortoise.

Nevertheless, this suggestion has served to direct attention to points of special interest and importance, viz., the striking influence exerted by the representation of a well-known creature, the macaw, on the craftsmen who were set the task of modelling the elephant, which to them was an alien and wholly unknown animal. It explains how, in the case of the latter, the sculptor came to mistake the eye for the nostril and the auditory meatus for the eye, and also to employ a particular geometrical design for filling in the area of the auditory pinna.

In a memoir now in course of preparation I have discussed more fully the extensive literature relating to this elephant-controversy, and considered the problems arising out of it. In particular I have directed attention to a most remarkable confirmation of the identification of these American elephants. The series of beliefs which the ancient population of Mexico associated with Tlaloc, their elephant-headed god of rain, thunder, lightning, and agriculture (and the people of Yucatan with the proboscidean Chac), reproduce with the most amazing exactness the essential elements of the Hindu legends concerning Indra, the god of rain, thunder, and lightning, who was also associated with the elephant. Both were associated with the east and with the tops of mountains. Indra's most famous exploit was the slaying of "the snake Vritra, the restrainer, who catches and keeps in the clouds the rain that is falling to earth" (Hopkins, "The Religions of India," 1902, p. 94). Tlaloc is credited with similar performances (Joyce, "Mexican Archæology," 1914, p. 37). In the Codex Tro-Cortesianus Tlaloc is represented treading upon the head of a serpent who is interposed between the rain the god is pouring upon the earth (*Zeitsch f. Ethnologie*, 1910, p. 75, Fig. 837—in my previous letter I wrote "*Archiv*" instead of "*Zeitsch.*"). In the Codex Cortes (*op. cit.*, Fig. 839) the snake is shown coiled to surround and retain the water.

Coincidences of so remarkable a nature cannot be due to chance. They not only confirm the identification of the elephant-designs in America, but also incidentally point to the conclusion that the Hindu god Indra was adopted in Central America with practically all the attributes assigned to him in his Asiatic home.

G. ELLIOT SMITH.

The University of Manchester, December 3.

Electric Conductivity of the Atmosphere.

ONE of the Notes in NATURE of November 25 (p. 351) begins with the following sentence:—"The theory that the upper layers of the atmosphere are ionised and therefore conduct electricity, first enunciated by the late Prof. FitzGerald in 1893, . . ." It is a good rule, to which I have always hitherto adhered, not to raise questions of priority, but in this particular case a point of general interest in scientific history is involved, and a claim made which postpones the enunciation of a fruitful idea by six years. In the paper presented to the Royal Society in May, 1887 (Proc. Roy. Soc., vol. xlii., p. 371), I proved by experiment that the gas in a vessel through which an electric discharge passed became a conductor even in regions of the vessel remote from the discharge, and at the end of the paper the application of this result to the conductivity of the regions of the atmosphere affected by thunderstorms and auroræ is quite clearly expressed.

On first reading the paragraph in NATURE, I thought that the writer wished to lay stress on the word "ionisation," an expression I avoided for reasons which I need not enter into here, but on referring to FitzGerald's Collected Papers I find that in the only paper dated 1893 which deals with the subject the word is not made use of, and further, that the author does not claim any novelty for the idea, but refers to the conductivity of the atmosphere as an established fact. The term "ionisation" was first used by Arrhenius in describing experiments similar to mine, made independently but published somewhat later.

To avoid misunderstandings, I may add that in all the experiments above referred to the carriers of electricity, or "ions," as we should now call them, were considered to have molecular dimensions, as in the case of electrolytes. The idea of "corpuscles" of much smaller masses, afterwards introduced with such important results by Sir Joseph Thomson, belongs to a different chapter of the history of the subject.

ARTHUR SCHUSTER.

Yeldall, Twyford, Berks, November 29.

Viscosity of Cobbler's Wax.

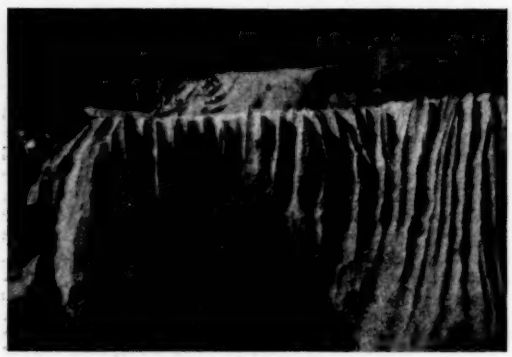
FOR slowly damping a vibrating instrument of importance to the Navy, I let a metal knife cut through cobbler's wax, which is just soft enough to be squeezable between the fingers. The actual softness or hardness of the wax does not greatly matter, but what does matter is its becoming very much softer when its temperature increases from 15° C. to 30° C. This is its defect. I write in the hope that some one of your readers may be able to tell me of a suitable substance which will vary less in its softness as its temperature changes. JOHN PERRY.

25 Stanley Crescent, Notting Hill, W.,
December 9.

The Cause of Fluted Weathering.

HAS the cause of fluted weathering, I would like to ask, ever been determined? It differs widely from all other forms of weathering that I have seen or read of. The long, smooth, parallel grooves are met with sometimes on the two sides of a block of limestone when such lies so that there are roof-like surfaces uppermost. On these two sides they frequently correspond at the ridge and follow a direct course downwards unless compelled to curve round some projecting boss.

The grooves may be 3 ft. long and of about equal



Fluted weathering in limestone, Italy. ×⅓.

width and depth along their whole course. The only specimen known to me in English museums is in the Oxford University Museum, which was got by Prof. W. J. Sollas from the Gemmi pass. I have seen good examples in the Jurassic limestone of Liguria, especially on the west of Finalmarina. Behind Pietra, on the left of the footpath to Ranza, the block, shown in this illustration, with several others, were seen. They were under olive trees, but it seemed impossible for such fluting to be produced by drip, and I wonder whether it could be the result of heavy dews or to some zoning influence. G. ABBOTT.

2 Rusthall Park, Tunbridge Wells, December 4.

Winter Thunderstorms.

THOSE of your readers who may observe thunderstorms in the British Isles during the winter months would give great assistance to an investigation of thunderstorms on which I am engaged if they would report by postcard when they observe lightning or thunder during this winter. When sheet lightning is observed at night the time and direction should be given, and a note as to whether many flashes were seen or whether there were only two or three. When thunder is heard the time should be given, and the direction of the storm; it should also be stated whether lightning was seen and whether rain occurred. Much useful information might be gained from winter storms, but as thunderstorms may be very local they may sometimes be missed by the official observers; I should therefore gladly welcome help from anyone who is good enough to send me information. It is obvious that only winter storms can be dealt with in this way; I would therefore ask those who are willing to help to send information up to March 31st only.

CHARLES J. P. CAVE.

Meteorological Office, South Farnborough, Hants,
December 9.

The Quadrantid Meteors.

THE ensuing display of these meteors occurs in the absence of moonlight. If the maximum continues to be at about the same position of the earth's orbit as formerly it will be in the early evening of January 3, which would be a convenient time for observation, although the radiant point is comparatively low then, the morning displays being the best.

T. W. BACKHOUSE.

West Hendon House, Sunderland, December 6.

LABORATORY ELECTRIC FURNACES.

MANY of the modern methods of chemical analysis involve the use of furnaces for the prolonged heating of materials; for example, the determination of carbon in steel, the carrying out of sealed-tube operations, etc., may be cited. Until recently, gas furnaces have almost exclusively been used for such purposes, but it seems probable that these will be largely replaced, in the future, by the improved types of electric furnace which are now obtainable. The electric furnace offers many advantages over the gas furnace, particularly in cases where it is desirable to maintain a constant temperature for any length of time.

The introduction of the comparatively new high resistance alloys of small temperature-coefficient has greatly simplified the construction and working of wire-wound furnaces. Such a furnace consists in its essential details of a tube of refractory material such as fireclay, alundum, or silica, upon which is wound a suitable length of the wire or strip; the tube is then supported in a case, the intervening space being filled with a material of low thermal conductivity, magnesia, for example. To ensure a long life and satisfactory running, attention must be paid to certain constructional details. The principal of these are:—(1) That the wire employed is as thick as possible, consistent with the dimensions of the tube and the voltage of the supply on which it is intended to be used; (2) that the wire is effectively protected from oxidation by preventing the access of air, the winding being for this purpose surrounded by a layer of powdered quartz or other suitable material; and (3) that the furnace is designed for and worked at the lowest voltage convenient.

In deciding upon the amount of lagging necessary, the purpose for which the furnace is to be employed must be considered. The provision of

thick and efficient lagging makes the furnace economical in that a comparatively small amount of energy is required to maintain it at any definite temperature; it, however, renders the furnace very sluggish, and for some operations this is a disadvantage. The ability to change the temperature rapidly and to adjust the new temperature quickly to a definite and constant value is a factor which frequently outweighs any small advantage accruing from a low power consumption.

We may consider for a moment the question of the power consumption of an electric furnace. A reasonably well-lagged furnace, with a tube, say, 1 in. internal diameter and 24 in. long, heated to the full temperature of 1000° C. over the central 18 to 20 in. of its length, should consume power at the rate of about 400 to 500 watts. This refers to the furnace itself, and it must be borne in mind that there is always an unavoidable amount of energy lost in the regulating resistance used in series with the electric furnace. This will

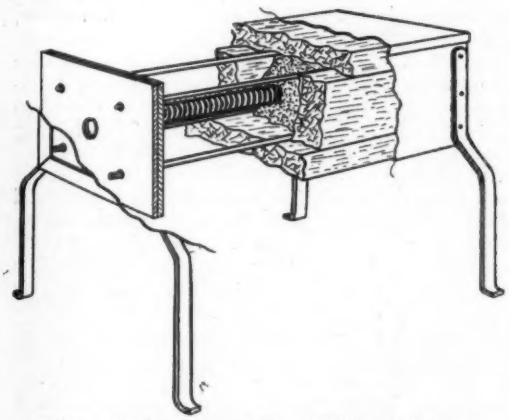


FIG. 1.—Sectional diagram of Messrs. Gallenkamp's furnace.

frequently amount to more than 50 per cent. of that usefully consumed in the furnace, and the loss cannot be overcome if provision is to be made for a fairly wide range of furnace temperatures. The external loss may be reduced for furnaces always run at a definite temperature; as in this case the winding may be so chosen to require only a small external resistance or even to dispense with it altogether. The latter procedure is not generally to be recommended owing to the lack of control thereby introduced.

If it be desired to maintain the temperature of a furnace constant to within about 20° C., it will often be found that the voltage of the commercial power circuit is not sufficiently steady for the purpose. A fluctuation of 5 per cent. in the voltage is not unusual, and the energy, and consequently the temperature, changes are thus of the order of 10 per cent. Rapid variations above and below a mean value are not of great importance, as the effect of these is damped out by the lag of the furnace. The intermittent use of large motors, etc., on the same energy distribution system is, however, a frequent source of trouble. The most accurate temperature control can be obtained by running the furnace off a large capacity storage battery.

To assist in the control of an electric furnace, it is always desirable to include an ammeter in the supply circuit. For a furnace wound with a low temperature-coefficient alloy, such as "nichrome," the current readings alone form a useful indication to the behaviour of the furnace, as the resistance does not change to any very great extent. In the case, however, of a platinum or nickel wound furnace this is not sufficient, and the volt-drop across the furnace must also be measured. It will frequently be found that changes in the regulating resistance in series with a platinum furnace produce no marked changes in the current, the volt-drop on the furnace, however, being considerably affected. The use of a wattmeter is hence to be recommended for furnaces wound with materials the temperature-coefficient of resistance of which is high.

In the construction of some furnaces use is made of various fireclay cements to hold the wind-

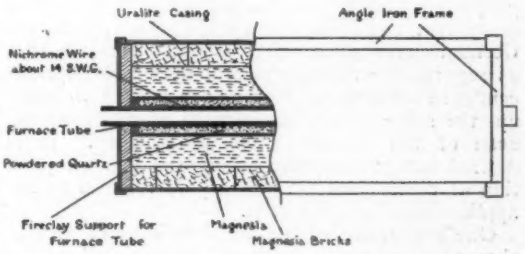


FIG. 2.—Diagrammatic representation of a typical wire-wound electric furnace.

ing in position on the tube. Except for furnaces which are not intended to run above 900° or 1000° C. this is undesirable, and a more satisfactory plan is to employ a tube on the external surface of which a spiral groove is moulded; such tubes may now be obtained in a variety of sizes from the leading makers of refractory materials. The ends of the winding should be held firmly in position by being bound with a few extra turns of the same material. At each end of the tube these wires, when tightly twisted together, will form multiple stranded leads serving for the current supply. The use of a different metal in contact with the winding is generally unsatisfactory, and the failure of a high temperature furnace is often due to this fault in construction. Another cause of failure which may be overlooked is the presence of a small piece of foreign matter or impurity in the lagging employed. If this comes into contact with the hot winding, it sometimes leads to fluxing of the wire and consequent breakdown of the furnace. The material used for lagging should hence be carefully examined, and, needless to say, it must be of such a nature that it will not react chemically

with the winding, even after long exposure at high temperature.

Some electric furnaces, embodying many of the points above referred to, have recently been put on the market by Messrs. A. Gallenkamp and Co., Ltd., London, and in the several designs available the needs of the chemist have been fully considered. The construction of a single-tube furnace is shown in Fig. 1. The lagging is provided by four slabs of a mixture of magnesia and asbestos, while the central space surrounding the wound tube is filled with powdered quartz. Electric furnaces for research work, and particularly for use at high temperatures up to 2500° C., may be obtained from Mr. Chas. W. Cook, of Manchester. He also lists a simple type of wire-wound combustion furnace for fixing on an ordinary retort stand. A similar furnace is supplied by Messrs. Baird and Tatlock, London, and should prove useful for many chemical operations.

OILS AND FATS.

CHEMICAL industry in Britain is now passing through a very critical period; many people are realising its importance, and it is being compared, not always to its advantage, with the German chemical industry. Whilst it is true that as regards the manufacture of dyes and pharmaceutical chemicals we have much leeway to make up, the same cannot be affirmed of all branches, even of the organic chemical industry. It is desired here to indicate briefly the present position of the oil and fat industry in relation to the application of science in it.

One illustration of the backwardness of applied chemistry in Britain which is often quoted by the would-be reformer is the lack of adequate text-books in English. In the great industry of oils and fats this reproach is certainly not justified; indeed, in Lewkowitsch's work[1] the industry possesses a text-book which is second to none, and has been translated more than once. Moreover, a challenge can be issued on behalf of this industry as one in which British foresight and enterprise have led the world. Whilst this success is in part due to the financial genius and organising ability of the founders of our great concerns, it is none the less principally based on the application of science, and probably in no other British industry has chemistry had such scope as in that connected with fats and oils. There is, perhaps, no better illustration of the chasm between the college and the factory, the existence of which was deplored by Dr. Forster at the annual meeting of the Society of Chemical Industry. The college has no idea of the knowledge of fats and oils possessed by the industry; writing with inside knowledge, this may be declared to be at least a decade ahead of the published literature. The colleges know not even the names of their industrial colleagues, or at least, like the proverbial prophets, these are without honour in chemical circles at home.

The third volume of Dr. Lewkowitsch's classic work gives a very complete summary of the technology of manufactured oils and fats, and even the most eminent expert will be certain to learn from almost any of its chapters. Unfortunately but a tithe of the knowledge which the writer really possessed of the actual working of the industry is recorded in its pages, doubtless because much of it had been acquired in confidence. As a consequence this, like other similar works, gives but an imperfect idea of the actual stage of development to which the industry has attained, and is to that extent disappointing when the manufacturer of to-day turns to it to help him out of his difficulties. All will agree, however, that Lewkowitsch's book is an integral part of the oil and fat industry, which his whole-hearted zeal and hard work did so much to advance, and that his all too early decease was a great misfortune.

The raw materials of the fat and oil industry are strikingly varied. At first limited in number, their scarcity and the consequent increase in value as the demand for soap and margarine grew have prompted a world-wide search to increase them, and chemical science has played an essential *rôle* in their development. Thus in early days soap was made in small works from tallow of local origin. As the works grew larger, tallow was imported to Europe from the large cattle and sheep raising districts in the New World. At the same time vegetable oils from the tropical countries began to be used for soap-making, and since the margarine industry also has learnt how to utilise such vegetable fats, the whole world has been laid under contribution to supply them. As most are the products of trees, their cultivation on any scale has not yet been successful, the exceptions being the oils from linseed, which is grown in temperate climates, and the soy bean of the East. Linseed oil is too unsaturated either for use in margarine or soap, but as a drying oil it has no equal. Until the discovery of the hardening process for saturating fats, the highly unsaturated whale oil and fish oils were of very limited application.

The manufacture of soap, an operation of great antiquity, is based on the simplest of chemical reactions, and even to-day in some countries it is carried out in a most primitive manner. This is in striking contrast to the up-to-date methods of the great British soap manufacturers, who have learnt how to make their soaps neutral so as to be without action on the skin or the most delicate fabrics; how to blend the fats which compose them so as to make soaps having any desired qualities; and even how to make the fullest use of the advance of physical chemistry, including such apparently academic branches as the phase rule.

Soap primarily requires a hard fat for its raw material; and with the margarine industry making the same request, the demand outstripped the supply. The situation might have become serious

[1] "Chemical Technology and Analysis of Oils, Fats, and Waxes." By Dr. J. Lewkowitsch. Edited by P. H. Warburton. Fifth edition. Vol. iii. Pp. viii+483. (London: Macmillan and Co., Ltd., 1915.) Price 20s. net.

from the point of view of the price of the raw materials if the success of the hardening process had not made the softer, unsaturated oils also available.

Few, if any, developments of recent years have been more remarkable and more truly chemical than that connected with the so-called hardening of fats—the realisation on an industrial scale of that very simple exercise in organic chemistry, the reduction of an unsaturated double bond by means of hydrogen. How simple it seems, and yet the leading expert on the chemistry of fats said not many years ago that it could not be done. Even Sabatier, the discoverer of the efficacy of metallic catalysts in the hydrogenation of vapours, expressly stated that his process failed with liquids. Normann's first patent for the hydrogenation of liquid fats was based, as all experimental work must be, on work done in the laboratory; there he was successful, and though his patent was crudely drawn—and who would have done better?—the great idea was there. Yet the successful application on the large scale took many years of arduous work and much capital expenditure. The German firm, Leprince and Sievke, who first bought Normann's process, made little of it, and parted with it to Joseph Crosfield and Sons, of Warrington, in whose hands it has been brought to its present success. The innumerable patents on the subject are little more than variations of the original idea of Normann—acts of piracy, for the most part, arising out of the present unsatisfactory condition of the patent laws. Yet a perusal of the most recent book on hydrogenation leaves the reader almost ignorant of the existence of the Warrington firm.

Not so many years ago glycerine was an almost worthless bye-product of the soap industry, and the spent lyes from the soap-pan were originally concentrated for the sake of the salt they contained. To-day the lyes are purified with the utmost care, and the glycerine is concentrated, distilled, and refined until the article sold is of quite remarkable purity considering its low price. The practical problem—one of chemical engineering—is to evaporate water from the dilute lyes until a crude glycerine is obtained at the cheapest possible cost. The contrast between the original shallow open pans heated by a fire and the elaborate multiple-effect vacuum evaporators with salting arrangements which are used to-day is a striking one. It is typical of the advances made in chemical engineering, a branch of the chemical profession which is as important industrially as that of the laboratory worker.

The stearine candle industry has lost ground owing to the powerful competition of gas and electricity in towns and the development in the use of cheaper paraffin, but it is still of importance both in England and abroad. The old empirical methods of preparing and blending the raw materials have given way to modern processes based on the knowledge of the chemical properties of the substances concerned.

Equally important as chemical achievements must rank the great developments in the processes of refining oils so as to render vegetable oils in particular available for edible purposes. This branch of the subject was described at some length in NATURE of April 8 (vol. xcv., p. 145).

Space forbids more than brief reference to the industries concerned with lubricating oils or with boiled oils for making varnishes and paints. The latter are almost wholly concerned with linseed oil, and their problems are connected with oxidising and changing the oils.

The outlook for the future in these industries in Britain may be faced with confidence. The tendency to aggregate the production in large factories enables a competent staff of chemists to be employed, and avoids the pitfalls consequent in the practice of rule-of-thumb methods in small concerns. Competition ensures the constant striving to invent and develop new and cheaper processes, and at the same time safeguards the public interests by providing them with a cheap article, the low price at which fat and oil products are retailed at the present day being one of the most remarkable testimonies to the development of the industry.

THE DYE FAMINE IN AMERICA AND THE PROPOSED REMEDY.

RECENT issues of the *Scientific American* (November 6 and 13) contain articles by Prof. T. H. Norton, of the Bureau of Foreign and Domestic Commerce, Washington, dealing with the prevailing shortage of dyes in the United States. For some months after the outbreak of the European war, American importers were able to secure an almost normal supply of synthetic dyes, but during the last seven months, owing to the embargo on the shipment of German dyes to neutral countries, only 50 tons of such colouring matters have reached America, together with small amounts of dyes of Swiss origin.

Before the war, American dye factories employed not more than 400 workmen and produced annually 3000 tons of dyes, these colours being prepared chiefly from intermediate coal-tar products made in Germany.

After a systematic examination of the dye problem by the Department of Commerce, the Secretary of Commerce, on September 30, outlined the policy of the present administration in regard to the protection to be afforded to American chemical enterprise against unfair attacks by foreign rivals. In the meantime, prompt and resolute decisions had been made by the industrialists, and considerable investments were made in new plant, two new companies having an authorised capital of 400,000*l.* and 3,000,000*l.* respectively. The output of American coal-tar colours has been doubled and will soon be trebled, while the production of benzene and toluene has increased fivefold. Owing to the extensive manufacture of explosives, it is difficult at present to secure large quantities of these hydrocarbons for colour production. But twelve firms have nevertheless embarked on the manufacture of aniline, the Edison Company now turn-

ing out three tons of this intermediate product daily. A remarkable and novel development has arisen in this branch of the colour industry. The firms engaged in dyeing aniline black are setting up small aniline plants costing 300*l.* to 400*l.* each, capable, under the supervision of one operative, of producing daily 100 lb. of aniline from benzene.

At present the seven companies engaged on finished coal-tar dyes are restricting drastically the number of colours produced, and are concentrating on increased output. Two works are specialising in an ample supply of chlorodinitrobenzene, from which two other well-equipped factories are manufacturing sulphide black on a huge scale. Synthetic indigo is receiving the attention of four powerful chemical companies.

Although the existing equipment for natural dyes installed in six large American works has proved to be a national asset of great value, yet the total supply of dyes is still far short of customary requirements, and the American public is urged to meet the abnormal situation in a spirit of generous compromise. The existing shortage will soon disappear, inasmuch as the United States possess all the enterprise, inventive talent, and technical ability requisite for the development of an American dye industry. As regards the practical experience of industrial colour syntheses, it is suggested that the services of a corps of expert Swiss colour chemists would be of untold value in accelerating the evolution of the new industry. This scheme has already been adopted successfully in Russia, where a group of dye consumers have formed a company, including as a constituent member a leading Basle firm, which supplies a technical staff to the enterprise.

One reason for the former dominance of German colour chemistry was the unity and solidarity of the various firms engaged in this industry, so that when one was menaced by any foreign competitor they all acted in unison. In America the field has been entered by many separated interests imperfectly acquainted with the complexity of the colour problem. A plea for a higher degree of unity is put forward in order to avoid overlapping and duplication of effort. It has been proposed to establish Government factories for the production of coal-tar intermediates, these factories to be available for manufacturing explosives in case of war. A national bureau of standards for dyestuffs would afford considerable protection to the growing industry, and a similar result would be attained by organising the consumers of dyes.

In view of these developments, it appears certain that in a few years America will be practically self-contained as regards dyes. It is not at all probable that the vast industrial organisations by this time established will content themselves with catering only for the American market, especially as the United States possess sufficient of the needed raw materials to supply the whole world's dye industry. British dye producers must expect to face, not only furtive attempts to recover trade by German competitors, but also a direct frontal attack on their home, colonial, and foreign markets by dye-wares of American origin. The only way of meeting this invasion will be by a combination, first of British manufacturers among themselves, and secondly a co-operative union of the British group with similar groups representing the other nations of the Quadruple Entente. The pooling of our resources for war will need to be followed by a partnership in original ideas, technical organisation, and natural resources in regard to the chemical industries of the allied nations. G. T. M.

OPTICAL INVESTIGATION OF ETHER-DRIFT.

OF all the attempts made to detect a possible influence of the motion of the medium on optical phenomena, the only one giving a positive result, was the celebrated experiment of Fizeau, in which interference was produced between two beams of light which passed along tubes containing running water, the one beam going with the current and the other beam against it. When the direction of the current was reversed the bands were displaced, and the displacement could be explained on the assumption that the ether in the tubes drifted with the current with a velocity $v(1-1/\mu^2)$, where v is the velocity of the water. Fizeau obtained a 14 per cent. agreement between theory and experiment, which was regarded as satisfactory in view of the difficulty of the subject. The experiment was afterwards repeated by Michelson and Morley with more refined means, and they obtained a difference of less than 1 per cent. with a calculated probable error of about 5 per cent.

In 1895, however, in his "Versuch einer Theorie der electrischen und optischen Erscheinungen in bewegten Körpern," Lorentz gave a new expression for the velocity of the ether drift, namely:—

$$v\left(1-\frac{1}{\mu^2}-\frac{\lambda}{\mu}\frac{d\mu}{d\lambda}\right).$$

This expression is also obtained on the theory of relativity. In the case of water it is quite 3 per cent. larger than Fresnel's value. We have just received two papers reprinted from the Proceedings of the Amsterdam Academy, which describe an elaborate experimental investigation made by Prof. Zeeman at Amsterdam to decide between the two expressions. (Vol. xvii., pp. 445–451, 1914, and vol. xviii., pp. 398–408, 1915.)

The interference fringes were produced by Michelson's method. The length of the tubes was 6 metres and the maximum velocity of the water 5·5 metres per second. As the expression to be tested varies only slightly with the wave-length, the light of an arc lamp could be used as source after it passed through a monochromator. The fringes were recorded photographically; the cross-wires in the focal plane of the telescope came out on the negative, and the displacement of the fringes relative to the cross-wires was

measured. The exposures were from three to five minutes. Photographs are given in the second paper showing the displacement of the fringes for three different points in the spectrum. The results are summarised in the following table:—

Wave-length	Fresnel coefficient	Lorentz coefficient	Experimental value
4500	0·443	0·464	0·465
4580	0·442	0·463	0·463
5461	0·439	0·454	0·451
6870	0·435	0·447	0·445

The calculated probable error of the experimental result is about 1 per cent. of the latter.

The experiment decides conclusively in favour of the Lorentz coefficient. Not only does the absolute value of the result agree better with the latter, but so also does its variation with the wave-length, the figure for the experimental value being 1616 and the figures derived respectively from the Fresnel and Lorentz coefficients being 1572 and 1608. Thus the degree of accuracy has been pushed a stage further in what was regarded as one of our most accurate experiments.

SCIENCE AND WAR.

WE are permitted to publish this week some passages from Sir William Osler's address to the Leeds Medical School on "Science and War" (Oxford: At the Clarendon Press. Price 1*s.* 6*d.* net). Sir William writes with authority and with distinction: and all who love good thoughts arrayed in good style ought to buy this address and read it with care. He keeps his head clear, though he has chosen a theme vast beyond imagination. The war transcends our powers of thought; so does science. The war has gone beyond us; so has science. Yet he is able, more than most of us, to measure the working together of the immeasurable forces of science and war: for he has always in his head, and in his heart, the duplicity of science. "I bring to life, I bring to death," says Science. In the war, my Lady Science is busy both ways. She employs artists in death and artists in life; she supplies them—so impartial are abstractions—with asphyxiating gases and with antiseptic dressings; she manufactures with equal mind high explosives and protective vaccines, submarines and motor-ambulances. What a thing it is to be an abstraction, a name for systematised thought; to have no morals, no likes or dislikes; to be nothing but a Latin word for the best way of doing what is to be done.

Sir William Osler, as a true man of science, gives an admirable and well-balanced account of this dual influence of scientific method on the war. He is not only a man of science: he is also a great physician, a notable artist in life. His account of one of the chief base hospitals in France is delightful reading; the speed and precision and modernity of the work achieved are above praise. A strong committee has already taken in hand the compiling of the medical and surgical history of the war. It will be a mighty book. The medical and surgical history of the American Civil War is in five huge volumes; we can scarcely have less than that for the present war.

Toward the end of the address, Sir William says what a good many of our great doctors are saying or thinking. "To one who is by temperament and education a Brunonian and free from the 'common antipathies' and 'national repugnances,' one sad sequel of the war will be, for this generation at least, the death of international science." He thinks that science will suffer grievously by some sort of boycott against Germany; he dreads what he calls "Chauvinism in science." He says that "an impassable intellectual gulf yawns between the Allies and Germany." We think that he makes too much of this fear. The gulf between the Allies and Germany is ethical, not intellectual. There will be friendships broken, and international medical congresses made impossible, and no more honorary degrees from German universities, and no hospitality for hospital workers, and so forth; but these losses will be easily tolerable. Science has her own ways of getting back a bit of her own.

The following extracts from Sir William Osler's address may serve to illustrate its wisdom and style:—

In Time our civilisation is but a thin fringe like the layer of living polyps on the coral reef, capping the dead generations on which it rests. The lust of war is still in the blood: we cannot help it. There was, and there is as yet, no final appeal but to the ordeal of battle. Only let us get the race in its true perspective in which a thousand years are but as yesterday, and in which we are contemporaries of the Babylonians and Egyptians and all together within Plato's year. Let us remember, too, that war is a human development, unknown to other animals. Though nature is ruthless "in tooth and claw," collective war between members of the same species is not one of her weapons; and in this sense Hobbes's dictum that "war was a state of nature" is not true. The dinosaurs and pterodactyls and the mastodons did not perish in a struggle for existence against members of their own species, but were losers in a battle against conditions of nature which others found possible to overcome. In our own day the gradual disappearance of native populations is due as much to whisky and disease as to powder and shot, as witness in illustration of the one the North American Indian and of the other the Tasmanians.

Some of us had indulged the fond hope that in the power man had gained over nature had arisen possibilities for intellectual and social development such as to control collectively his morals and emotions, so that the nations would not learn war any more. We were foolish enough to think that where Christianity had failed science might succeed, forgetting that the hopelessness of the failure of the Gospel lay not in the message, but in its interpretation. The promised peace was for the individual—the world was to have tribulations; and Christ expressly said: "Think not that I am come to send peace on earth; I came not to send peace but a sword." The Abou ben Adhems woke daily from their dreams of peace, and lectured and published pamphlets and held congresses, while Krupp built 17-inch howitzers and the gun range of the super-Dreadnoughts increased to eighteen miles!

And we had become so polite and civil, so cultured in both senses of that horrid word, with an "Is thy

servant a dog?" attitude of mind in which we overlooked the fact that beneath a skin-deep civilisation were the same old elemental passions ready to burst forth.

In spite of unspeakable horrors war has been one of the master forces in the evolution of a race of beings that has taken several millions of years to reach its present position. During a brief fragment of this time—ten thousand or more years—certain communities have become civilised, as we say, without, however, losing the savage instincts ground into the very fibre of their being by long ages of conflict. Suddenly, within a few generations, man finds himself master of the forces of nature. In the fulness of time a new dispensation has come into the world. Let us see in what way it has influenced his oldest and most attractive occupation.

Science is a way of looking at the world taught us by the Greeks—a study of nature with a view of utilising her forces in the service of man. It "arose from the simplest facts of common experience, and grew by the co-operation of the mass of men with human intellect at its highest. And when developed it returns again to strengthen the common intelligence and increase the common good. Above all, more perfectly than any other form of thought, it embodies the union of past and present in a conscious and active force."[1] Man's latest acquisition, it has worked a revolution in every aspect of his life, without so far changing in any way his nature. He is still a bit bewildered, and not quite certain whether or not the invention is a Frankenstein monster. The promise of Eden of full dominion over nature has only been fulfilled in our day. The flower and fruitage has come suddenly within a couple of generations. Even the seed time was but a few years ago, for to the Heidelberg man, looking down the ages from the Glacial period, Aristotle and Darwin are contemporaries, Galen and Lister fellow practitioners. Steam and electricity have upset our weekday relations, and the theory of evolution our Sundays. Like a beggar suddenly enriched man has not yet found himself; and the old ways and old conditions often sort ill with the changing times. New bottles could not always be found for the new wine.

Organised knowledge, science, if living, must infiltrate every activity of human life. There was a difficulty in these islands, which of fruitful ideas, inventions, and discoveries have had the lion's share, but failed to grasp quickly their practical importance. The leaders of intellectual and political thought were not awake when the dawn appeared. The oligarchy who ruled politically were ignorant, the hierarchy who ruled intellectually were hostile. Read of the struggles at Oxford and Cambridge in the "fifties" and "sixties" of the last century to get an idea of the attitude of the intellectual leaders of the country towards "Stinks," the generic term for science. It was not port and prejudice, as in Gibbon's day, but just the hostility of pure medieval ignorance. Those in control of education were more concerned with the issues of Tract 90 and the Colenso case than the conservation of energy and "The Origin of Species." To take but one example. What a change it might have wrought in rural England if, in 1840, when the distinguished Prof. Daubeny was made professor of rural economy, Oxford could have had great State endowment for an Agricultural College. The seed was abundant, and the soil was good, and only needed the cultivation that has been given so freely by members of the past generation, with what results we see to-day at Oxford and Cambridge and in the new universities.

[1] Marvin. "The Living Past," second edition, 1915.

In two ways science is the best friend war has ever had; it has made slaughter possible on a scale never dreamt of before, and it has enormously increased man's capacity to maim and to disable his fellow man. In exploiting the peaceful victories of Minerva, Mars has added new glories to his name. More men are killed, more men are wounded, and consequently more men are needed than ever before in the history of the world's wars. From 1790 to 1913 there were 18,552,200 men engaged in the great wars, of whom 5,498,097 lost their lives (D. E. Smith). In the Balkan wars of 1912–13 there were 1,230,000 men engaged, of whom 350,000 were killed. In the Russo-Japanese War there were 2,500,000 men, of whom 555,900 lost their lives (D. E. Smith). It is estimated that in the present war more than twenty-one millions are engaged! As weapons have improved the losses will be yet greater, and we may expect that at least five or six millions of men in the prime of life will be killed. Within a few years artillery and high explosives, submarines, and aircraft have so revolutionised our methods of warfare that thousands are now destroyed instead of hundreds. The rifle and the bayonet seem antiquated, and one may go from hospital to hospital and not see a wound from the latter, and comparatively few from the former.

In three directions science has scored in a mission of destruction. What a marvellous adaptation of physics, pneumatics, and mechanics is displayed in a submarine, with which the highest standard of wholesale destruction is reached. In a few seconds a vast battleship, itself a product in every part of scientific genius, is blown asunder and a thousand men and boys sent flying into eternity. Or a colossal liner like the *Lusitania*, laden with harmless non-combatants, is torpedoed without warning and above 1200 perish miserably, to the inexpressible delight of a kultured nation, whose school children celebrated the event with a holiday.[2]

On land the field-guns, howitzers, and machine-guns have increased enormously our killing capacity; so much so, indeed, that in self-defence the armies have taken to earth, and from the North Sea to the Alps Europe has become a rabbit warren. High explosives, long-range accuracy, and quickness of fire have made the artillery arm the most effective of the Service. Every device of science has been pressed into use, and the aeroplanes with their observers and cameras have plotted the entrenched lines to checker boards, on to any square of which a rain of shell and shrapnel may be poured. The high-explosive shells, the "Jack Johnsons," and the "Black Marias" have played a great *rôle* in the present war, and not only do they kill and maim, but the shell-shock from commotion puts a large number of men out of action. Against the great Krupp howitzers the forts of Europe have gone down like cardboard houses.

Artillery and quick-firing machine-guns follow hard upon the torpedo as agencies of destruction. Against an oncoming enemy 20 per cent. of men and 60 to 80 per cent. of horses are hit by separate bullets within the "mown area."

Theoretically all is fair in war, but by common consent certain practices regarded as cruel are tabooed, such as the use of explosive bullets. Not so in the present war. Never before has anything been used by man to kill his fellow man equalled in diabolical capacity for cruelty the use by the Germans of irrespirable gas. Had it been a suddenly asphyxiating vapour, such as may have been the breath of the angel of death as he passed over the host of Sennacherib, the action would not perhaps have been thought any more reproachful (in war) than wholesale drowning

[2] Owen Wister, "The Pentecost of Calamity," p. 55.

by the torpedo. But this was a very different matter —agonising suffocation to those who could not escape; many for days gasped out their lives in a slow process of strangulation, others had a lingering illness with urgent dyspnœa, cough, and inflammation of the lungs. The worst types of cases were, I am told, appalling to witness—some who reached England were bad enough.

It is not a little remarkable that the aspect of the war which caught the popular fancy and from which so much was expected has proved comparatively harmless from a killing point of view. "The rain of ghastly dew" of Tennyson's vision, which the Wright brothers and Zeppelin have made possible, is more destructive of property than of life. But the mastery of the air is one of the greatest of the conquests of science. How Leonardo da Vinci would have rejoiced, in this day predicted so confidently by him, to see flocks of wonderful bird-men as much at home in the air as eagles! The development of aircraft and air-guns has added a new arm to the Service, but battles of the airy navies grappling with each other or attacked by shells from land leave few wounded, and the total killed so far is small. An enormous value for observation and the shock of righteous indignation roused all over the world by the Zeppelin murders of women and children have been, so far, the chief assets of the air.

Enough of this. Let us turn to the other side of the picture; let us see what science has done in a mission of salvation amid the horrors of war. Through the bitter experiences of the Napoleonic wars, of the Crimea, of the American Civil War, and more particularly of the recent campaigns, there has been evolved a wonderful machinery, replete with science, for the transport and care of the sick and wounded. There must be suffering—that is war—but let us be thankful for its reduction to a minimum, through the application in every direction of mechanical and other pain-saving devices.

If the foes of our own household, the "anti's," would spend a few days at a hospital for infectious diseases, see the modern methods, and learn a few elementary facts about immunity, they could not but be impressed with the applications of scientific horticulture to disease, and be lost in admiration of a technique of extraordinary simplicity and accuracy.

The second great victory of science in war is the prevention of disease. Apollo, the "far darter," is a greater foe to man than Mars. "War slays its thousands, Peace its ten thousands." In the Punjab alone, in twelve years, plague has killed two and a half millions of our fellow-citizens. This year two preventable diseases will destroy more people in this land than the Germans. The tubercle bacillus alone will kill more in Leeds in 1915 than the city will lose of its men in battle. Pestilence has always dogged the footsteps of war, and the saying is true—"Disease, not battle, digs the soldier's grave." Bacilli and bullets have been as David and Saul, and at the breath of fever whole armies have melted away, even before they have reached the field. The fates of campaigns have been decided by mosquitoes and flies. The death of a soldier from disease merits the reproach of Armstrong:—

> Her bravest sons keen for the fight have dy'd
> The death of cowards and of common men—
> Sunk void of wounds and fall'n without renown.

This reproach science has wiped away. Forty years ago we did not know the cause of any of the great infections. Patient study in many lands has unlocked their secrets. Of all the great camp diseases—plague, cholera, malaria, yellow fever, typhoid fever, typhus, and dysentery—we know the mode of transmission, and of all but yellow fever the germs. Man has now control of the most malign of nature's forces in a way never dreamt of by our fathers. A study of her laws, an observation of her facts—often of very simple facts —has put us in possession of life-saving powers nothing short of miraculous. The old experimental method, combined with the new chemistry applied to disease, has opened a glorious chapter in man's history. Half a century has done more than a hundred centuries to solve the problem of the first importance in his progress.

Lastly, in the treatment of wounds science has made great advances. The recognition by Lister of the relation of germs to suppuration, an outcome of Pasteur's work, has done away with sepsis in civil life. High explosives, shell, and shrapnel make wounds that are at once infected by the clothing and dirt, and are almost impossible to sterilise by any means at our command, but with free drainage, promotion of natural lavage from the tissues by Wright's method, and the use of antiseptics when indicated, even the most formidable injuries do well. The terrible laceration of soft parts and bones adds enormously to the difficulty of treatment. The X-ray has proved a boon for which surgery cannot be too grateful to Röntgen and to the scores of diligent workers who have given us a technique of remarkable accuracy. Other electrical means for detecting foreign bodies have also given good results.

Of the germs blown into wounds from the soil and clothing and skin the pus-formers are the most numerous and most important. Two others have proved serious foes in this war, the germ that causes gas gangrene and the tetanus bacillus. I am told that methods of treatment of wounds infected by the former are giving increasingly good results. The soil upon which the fighting has occurred in France and Flanders is rich in the spores of the tetanus bacillus; the disease caused by it was at first very common and terribly fatal among the wounded. For centuries it has been one of the most dreaded of human maladies, and justly so, as it is second to none in fatality and in the painful severity of the symptoms. No single aspect of preventive medicine has been more gratifying in this war than the practical stamping out of the disease by preventive inoculation. In the first six months of this year only thirty-six of those who were inoculated within twenty-four hours of being wounded suffered from tetanus.

And what shall be our final judgment—for or against science? War is more terrible, more devastating, more brutal in its butchery, and the organisation of the forces of nature has enabled man to wage it on a titanic scale. More men will be engaged and more will be killed and wounded in a couple of years than in the wars of the previous century. To humanity in the gross science seems a monster, but on the other side is a great credit balance—the enormous number spared the misery of sickness, the unspeakable tortures saved by anæsthesia, the more prompt care of the wounded, the better surgical technique, the lessened time in convalescence, the whole organisation of nursing; the wounded soldier would throw his sword into the scale for science—and he is right.

NOTES.

THE Romanes Lecture on "Science and the Great War," delivered by Prof. E. B. Poulton at Oxford on December 7, and published by the Clarendon Press, was a scathing indictment of the ineptitude of the lawyer-politicians who possess a dominating influence on national affairs, and a plea for a fuller use of

scientific knowledge. To the neglect of science, and the excessive predominance in Parliament and in the Government of men with the spirit of the advocate to whom all evidence which will not support their case is unwelcome, Prof. Poulton ascribes the chief mistakes in the conduct of the war. The ignorance displayed in connection with the campaigns to make cotton contraband and to prevent the export of oils and fats, because of the use of these things in the manufacture of gun-cotton and nitro-glycerine, is as appalling as it is deplorable. In all such cases, when vital issues are at stake, our statesmen only make use of scientific evidence when the resources of political rhetoric have failed to justify their inactivity. The pity of it is that so much power should be in the hands of politicians and members of public services unwilling to recognise the important position which science must occupy in a modern State, in times both of war and of peace. Prof. Poulton mentions a number of matters in which scientific advice might have been applied with advantage much earlier in the war, but no appeal was made for such help, and the fate of suggestions was not encouraging. His address should help to enlighten the public as to the prime need of the country for men alert to take the utmost advantage of the power which science can offer.

A NOTE from the Imperial Institute refers to recent statements as to the present scarcity of certain drugs. The shortage and high price of atropine has been particularly commented on and attributed to "the dearth of belladonna, from which [according to this statement] atropine is extracted, and which is obtained from Central Europe." It is most desirable that this common misconception as to the sole source of atropine should be dispelled. Belladonna is one source, but a far more valuable source is (as was proved a few years ago by investigations at the Imperial Institute) the Egyptian hyoscyamus or henbane. This plant grows wild in the Egyptian desert and in the Sudan, and these countries are the sole source of the commercial supply. Before the war Egyptian henbane went to Germany for manufacture, but large quantities of the plant are freely available, and a considerable amount is now in the United Kingdom awaiting manufacture into atropine by drug manufacturers here. Eserine, also used in ophthalmic surgery, the dearth of which is alluded to in the same statement, is a product of the Calabar bean of West Africa, and presumably it is the extreme present pressure on the manufacturing resources of British drug manufacturers, rather than any scarcity of this British raw material, that is hindering the production of the drug.

PROF. E. A. SONNENSCHEIN, in a letter to the *Times* of November 4, described the good results he had obtained in the domestic use of coal through sprinkling a hundredweight of cheap slack with a solution of a tablespoonful of salt in a little less than a pint of water. It is difficult to account for the results achieved through the medium of about one part of a non-combustible and non-supporter of combustion with some two thousand parts of coal, and Prof. Sonnenschein said:—"I would also not exclude the possibility of a psychological process at work." Some explanation of the beneficent effect of this salt treatment has been put forward by Dr. A. Vernon Harcourt, in a letter to the *Times* of December 8. Dr. Harcourt says that the deliquescent property of the salt particles distributed on the slack serves to bind the small particles together, "so that a handful becomes a piece of coke, which burns with a steady glow, like the coke which lumps of coal after giving off their gases leave behind them." The improved combustion which Prof. Sonnenschein claimed may therefore arise from the better access of air in the absence of very small coal and dust, which frequently cause bad smoking in boiler practice from the choking of air passages through the fuel and the grate bars, but the "psychological process" must not be entirely overlooked.

THE Royal Geographical Society has received further news of Sir Aurel Stein's Expedition in a letter dated October 27, from Bokhara. He has done three months' almost continuous travelling down the Altaic region, across the Russian Pamirs, and along the whole length of the Upper Oxus valley. He has made important observations on geography and ethnography in this interesting region. Finally, he reached the railway at Samarkand, and he is now on his way to Meshed for his winter's work about Seistan. The Russian political authorities have been most courteous and helpful towards the expedition. In Wakhan, besides an important old trade route, he has been able to survey a series of ancient ruined strongholds. "Those secluded valleys," he writes, "have preserved a great deal of old-world inheritance in the ethnic types, languages, etc., of their inhabitants, and the materials I could collect are ample."

THE death is announced, in his seventy-first year, of Dr. George A. Heron, well known for his investigations in tuberculosis, and as the author of numerous medical works.

MR. O. A. DERBY, an American geologist who has been chief of the Geological Survey of Brazil since 1907, died on November 27 at Rio de Janeiro, at the age of sixty-four. He was a graduate of Cornell, and had served the Brazilian survey in various capacities since 1875.

THE *Geographical Journal* for December gives some particulars of the career and work of Dr. Richard Kiepert, whose death we announced in August last. Dr. Kiepert was born at Weimar in 1846, and gained his early experience in cartography with his father, Heinrich Kiepert, whose works he revised after his father's death. His contoured wall maps of the countries of Europe are among the best ever published. Among other important work of Kiepert was an atlas of the German possessions, a great part in the preparation of Richthofen's atlas of China, and, above all, a map of Asia Minor, which embodied all available information. For some time Kiepert was scientific director of Reimer's cartographical institute at Berlin, and from 1875 to 1887 he was editor of *Globus*.

MR. THOMAS PARKER, whose death occurred a few days ago, was not only a distinguished engineer, but a man of inventive and gifted mind, who, in addition to his ordinary labours, carried on investigations in realms far outside engineering. He first attracted

attention by his invention of a steam pump, and later came into further prominence through his investigations in electric batteries, the outcome of which was the foundation of a business which ranks to-day among the leading electrical works in England. It was while manager of the Coalbrookdale Company's works that he discovered the great value of concentrated nitric acid in facilitating the formation of the oxide in secondary batteries. R. L. G. Planté, who had been working on the problems of electrolytic polarisation since 1859, made a similar discovery, which resulted in the production of a cell having a high E.M.F., a low resistance, a large capacity, and almost perfect freedom from polarisation. The rival claims were contested in the courts, who divided the patent between Parker and Planté. In 1882 Mr. Parker entered into partnership with Mr. P. B. Elwell, and commenced manufacturing accumulators, and, later on, dynamos. This business was afterwards transferred to the Electric Construction Company of Wolverhampton, of which Mr. Parker became manager and engineer. During the five years which he occupied this position he designed the electrical plant for the Liverpool Overhead Railway. Later he became engineer of the scheme for electrifying the Metropolitan Railway in London. Mr. Parker was foremost in the electro-deposition of copper for subsequent use in the refining of copper, and the extraction of gold and silver. Then the smoke abatement problem occupied his attention, and he invented a slow-combustion grate, and a substance now known as coalite, which, though in appearance like gas coke, was easily ignited and burnt with a bright but smokeless flame. In 1894 he was awarded the Stephenson medal and Telford premium by the Institution of Civil Engineers.

By the death of Dr. Arthur Vaughan, at the early age of forty-seven, science has again to mourn the loss of a distinguished investigator. Vaughan's early training was in mathematics, which he made his chief subject at Cambridge, where he obtained a first class in both parts of the Mathematical Tripos. After applying his mathematics to an original investigation of certain problems presented by the earth's crust, he devoted himself with great ardour to geology, which had always been his favourite subject, especially on its palæontological side, with its bearings on the great problem of life. Some original work on the Jurassic beds of Somerset, accomplished in conjunction with his friend, Prof. Reynolds, prepared him for an attack on the zonal succession of the Lower Carboniferous rocks, a difficult problem which had resisted all previous attempts at solution. He commenced his investigation in the Avon Gorge, near Bristol, and achieved there a remarkable success. Having firmly established the succession in this section he extended his researches to adjacent regions, and then into provinces more remote, bringing into harmony the order of the Lower Carboniferous rocks and fossils in England, Wales, Ireland, Belgium, and elsewhere. The solution of this problem led to many fresh lines of inquiry, bearing on the laws governing the evolution of animal forms, and on the distribution of the Lower Carboniferous land and sea. While in the final stage of the disease from which he died he left the sanatorium at Buxton to give an account of his latest investigation on this last subject to the British Association at Manchester. In 1910 he accepted an invitation to the newly created post of lecturer in geology in the University of Oxford. Here his brilliant powers as a teacher were at once recognised; he gained the affection of his students and awakened their interest; indeed, it would have been hard to resist the stimulus of his lectures on "Palæontology and Evolution," with their suggestive views on the trend of the great currents of ancient life. He leaves unfinished an important text-book on palæontology, which had occupied many years of his life, and on which he was engaged up to within a few days of his death.

THE reading of Mr. S. H. Haughton's paper on a fossil man from Boskop, Transvaal, before the Royal Society of South Africa on October 20 (reported in NATURE of December 2 (p. 389), was followed by a discussion in which Dr. L. Péringuey expressed the opinion that none of the associated stones were human implements. It was very difficult to correlate the superficial deposits of South Africa with those of Europe, but it was clear that the Boskop man had no connection with the Neanderthal race. Both the Boskop specimens and another less fossilised human jaw which was exhibited must rather be compared with the corresponding bones of existing African types, to which they might be ancestrally related. As to the real importance of these remains there could be no doubt.

THE FitzPatrick lectures recently delivered by Dr. W. H. R. Rivers before the Royal Society of Physicians dealt with the relations between medicine, magic, and religion. Magic he defined to be a group of processes in which man used rites which depended on his own power, or on powers believed to be inherent in, or the attributes of, certain objects and processes which were used in these rites. Religion, on the contrary, dealt with processes dependent on a Higher Power, whose intervention was sought by rites of supplication or propitiation. But the savage mind distinguishes with difficulty between these two groups of ideas. Savage philosophy attributes disease to human agency, to some spiritual being, or to what we ordinarily call natural causes. He dwelt on the important part played by suggestion in the causation of disease among the Papuans and Melanesians, and he remarked that from the physiological point of view the difference between their rude methods and our medicine was not one of kind, but only of degree. The chief lesson to be learnt from the facts described was the rationality of the leechcraft of such peoples. They practised an art of medicine in some respects more rational than our own, for diagnosis and treatment followed more directly their ideas of causation. There were examples of leechcraft, such as the use of bleeding and massage in New Guinea, which did not follow a system so strictly logical and consistent. This led to another set of problems, the transformation of medical beliefs and practices as a result of contact and blending of peoples.

THE *Museums Journal* for December contains a very suggestive article on "Museums and Folk-art," more especially in reference to the folk-arts of the British Isles. Some striking examples of this art are

furnished by carved wooden spoons and stay-busks. These were wrought in the intervals of leisure, not for sale, but as offerings from men to their women-folk. Nor were they meant for use, but as pledges of affection, and hence the symbol of affection, the heart, appears in most of them. Specimens of such carvings, many of real beauty, add much to the value of this most helpful essay, which is unsigned.

THE Straits Branch of the Royal Asiatic Society has just published a valuable memoir on the Blattidæ, written by Dr. R. Hanitsch, the director of the Raffles Museum, at Singapore. In the main a compilation, embracing the descriptions of Malayan cockroaches scattered throughout numerous publications, yet much original work is contained in these pages. Dr. Hanitsch, indeed, describes herein nine species new to science. Furthermore, he has made a careful analysis of the geographical distribution of this group. This enables him to show, in the first place, that of 184 known species 131 are peculiar to the Malayan region, and in the second that the geographical distribution of the Blattidæ discounts the view that the Philippines should be included in the Indo-Malayan sub-region. Seven coloured plates add materially to the value of this most useful contribution.

MISS MAUD D. HAVILAND, in the December number of *British Birds*, records her notes made on the grey plover, at Golchika, on the Yenisei, during 1914. These notes chiefly concern the breeding habits of this bird, and form a valuable contribution towards our knowledge of this phase in its life-history. But she also makes some pertinent remarks on the spring migration of this species which are worthy of careful attention. In the same number Mr. H. F. Witherby continues his notes on the moults of the British passeres and the sequences of their plumages. In this he deals with the finches, which have but one annual moult, in the autumn. The snow-finch, however, he remarks, in the spring moults the throat feathers, while some of the nearly allied buntings, at this season, moult parts of the head, throat, and breast feathers. The "juveniles" among the finches in their first autumn usually moult only the body plumage and some of the wing coverts and inner secondaries. But the house-sparrow, tree-sparrow, and the snow-finch, the corn-bunting, and the East Siberian meadow-bunting have a complete moult in the autumn.

WE have received another useful pamphlet (No. 79) issued by the Imperial Department of Agriculture for the West Indies, dealing with "Diseases of Lime Trees in Forest Districts," by Mr. Nowell, mycologist to the department. The black-root disease, which may be caused either by *Rosellinia pepo* or *R. bunodes*, is somewhat common in Dominica, and is fully described in the paper. As it appears hopeless to try to cure infected trees, special attention is directed to methods of prevention of attack. Two other imperfectly known diseases, known as "red-root disease" and "pink disease," are also described; the former is known only from Dominica.

THE annual report of the Agricultural Department, Dominica, for the year 1914–15, is an interesting record of steady and well-marked progress. The budding of limes on hardy stocks receives attention in connection with the prevalence of root disease in certain districts. It is of interest to notice that though the yield of limes in the year under review was rather smaller than in 1913, the value of the crop was 44,369*l.* more. The high price is due to abnormal conditions, and it is stated that owing to Army and Navy requirements the output of raw lime juice was relatively large. The shipment of coconuts showed an increase, and the progress of the coconut industry is very satisfactory.

THE half-yearly meetings of the Agricultural Education Association were held in London during Smithfield week, under the chairmanship of Prof. Somerville. A paper by Dr. T. Milburn, of Lancashire, upon the subject of "Food Production During the Present Emergency," with special reference to war agricultural committees, was discussed, and some valuable suggestions were made in connection with the question of increasing home-grown produce. At the Agriculture Committee meeting, a discussion on the "Training of Women for Farm Work" was opened by Mr. P. Hedworth Foulkes, Harper-Adams Agricultural College, Newport, Salop, who pointed out the lack of facilities for training women in practical agriculture at the present time, and advocated that a minimum course of one month should be provided in such subjects as milking, general dairy work, poultry-keeping, care of stock, feeding and management, and field work of the lighter type. In the chemistry section Prof. Crowther, Leeds University, introduced the subject of the work of the agricultural chemist in relation to the war, and gave a summary of experimental work with palm nut cake, dried yeast, fish meal, etc., as regards their general suitability and value as feeding stuffs. Mr. Gimingham, of the Research Institute, Bristol, indicated the work that had been done with regard to the feeding value of pressed apple pomace and the possibility of the better utilisation of this waste product.

ONE effect of the present shortage of agricultural labour has been to stimulate interest in all kinds of labour-saving machinery designed for use on the farm. In the current number of the Journal of the Board of Agriculture there is an interesting account of the demonstrations of motor ploughs and tractors recently carried out by some of the county councils and agricultural associations. The machines tested ranged from 8 to 40 h.p., and from 158*l.* to 600*l.* in price. Petrol is the fuel used by the majority of the motors, but one or two run on paraffin, while the large steam tractors are fired with coal or coke. Both the light motor ploughs, combining both plough and motor, and the heavier tractors, hauling a detachable multi-furrow plough, will do good work under favourable soil conditions, but the former are more suitable when ploughing can be spread over several months, while the tractors are favoured where large areas have to be ploughed quickly, and where much haulage and threshing have to be done. These machines have hitherto only been manufactured in small quantities in this country, and their price is much higher than

it need be if the output were on a large scale. One of the well-known Detroit firms is said to have a 20-h.p. tractor, built on the usual lines of the cheap American car, which can be delivered in this country for 70*l*. In the reorganisation of agriculture which Lord Selborne has recently declared to be necessary after the war, it is certain that such labour-saving devices will play a leading part, and it will be a pity if this market cannot be held for our own manufacturers. It seems probable that in the future the demand for pleasure cars will not suffice to keep the existing motor works fully employed, and here is a field in which the manufacturer who has the necessary courage and foresight will reap a rich harvest.

IN a paper on storm frequency changes in the United States (*Monthly Weather Review*, August, 1915, xliii.) M. Henryk Arctowski touches on the problems of the relations of sun-spot activity to the terrestrial atmosphere. His discussion is based on the number and course of the low-pressure areas which crossed the meridian of 100° W. in the United States from 1883 to 1913. There were six storms fewer per year during the years of sun-spot minima than during the years of sun-spot maxima. This agrees with Kullmer's conclusion that years of sun-spot frequency are stormier than those of sun-spot minima, but in this case the increase was only 6·1 per cent. The difference in distribution throughout the year was much greater. Years of sun-spot minima were characterised by a more uniform latitude distribution throughout the year. During years of sun-spot maxima, on the contrary, the latitude distribution is more unequal, being to the north in February, September, October, and particularly November, and to the south from February to May. The action of the increase of sun-spots upon storms seems to be primarily one of co-ordination, and the conclusion is that the annual variation in the geographical distribution of atmospheric pressure must be essentially different in the years of sun-spot maxima from that during years of sun-spot minima.

MODERN mathematics has reached such a high degree of complexity and specialisation that only the shortest and simplest papers appeal to an extended class of readers. The Edinburgh Mathematical Society, in addition to its Proceedings, is now periodically publishing "Mathematical Notes," edited by Dr. G. D. C. Stokes, and printed by Lindsay and Co., Edinburgh. The contents consist mainly of alternative proofs of formulæ in elementary textbooks, much on the lines of similar work in the *Mathematical Gazette*; and on p. 193 we regret to note the presence of a divisor "sin 90°" in a problem on the solution of a right-angled triangle, an element the introduction of which should necessitate a deduction of marks by any examiner if he is really competent. Again, symbols and triangles figure to an extent suggestive of the predominance of similarly named instruments in the concert given in 1908 to the Mathematical Congress at Rome. We have mentioned the *Mathematical Gazette*, and it now remains to direct attention to a fly-sheet issued in the recent copy of that journal (October, 1915) headed "Books, etc., Received," containing a long list, not only of books, but also of periodicals, with lists of titles of contents. This list, while occupying little more than three pages of small print, meets a distinct want. Similar lists have previously been published in the Bulletin of the Calcutta Mathematical Society, and their utility has been fully recognised in these columns, but unfortunately these lists have usually been several years in arrears. At the same time, the fact that this list (if we have not made some oversight) does not contain a single paper on the mathematics of the aeroplane must be regarded, not only as an anomaly, but as a serious indictment against mathematicians.

THE December number of *Scientia*, although less bulky than in pre-war times, falls in no degree behind its predecessors in point of interest. In an article on the constitution of the luminous atom, Prof. Fabry, of the University of Marseilles, shows how, in seeking a suitable model which would have the radiating powers of the atom, it has been necessary to leave the classical dynamics, and that two paths have been opened up. In the first, due to Ritz, the active element of an atom is taken to be a small magnet about which an electron moves in a closed orbit. In the second, due to Bohr, the Rutherford atom—a central concentrated positive nucleus about which a number of electrons move as in a planetary system—is taken, and the difficulty that such a system would radiate its energy too rapidly, avoided by assuming that the energy is sent out only in bundles or quanta. By this means the spectra of hydrogen, helium, and other less simple substances have been reproduced with startling accuracy. In another article Prof. Bragg shows how X-ray spectroscopy sheds light on the constitution of crystals, and in a different field Prof. Ramsay Muir's article on the problems of the future peace, and Prof. Fedozzi's on the lessons the war has taught with regard to the treatment of foreigners domiciled in a country, will be read with interest.

A PAPER on the harbour and coast defence works at Alexandria, Egypt, was read at the Institution of Civil Engineers on November 30 by Mr. D. E. Lloyd-Davies. The city possesses two harbours, the western being under the jurisdiction of the Egyptian Government, and the eastern is being developed by the municipality. The first improvement of the access to the port was undertaken in 1889; the Gabbary dry dock was built in 1900, and important extensions were completed in 1911 at a cost of 282,770*l*., about 50,000*l*. less than the value of the lands reclaimed. The western port now ranks third, after Marseilles and Genoa, among the Mediterranean ports; it has 1850 acres of sheltered area capable of accommodating 250 large vessels 100 yards apart. The value of import and export trade rose from 18,856,000*l*. in 1880 to 52,075,000*l*. in 1908, and the revenue in 1911 reached 325,000*l*. Since 1906, when the author was appointed city engineer of Alexandria, the construction of breakwaters at the mouth of the bay has been proceeded with. These provide a fine pleasure harbour of 600 acres, an additional refuge for light commercial craft, and serve the purpose of protecting the sea-wall.

IN the *Atti dei Lincei*, vol. xxiv., No. 2, Prof. P. Pizzotti studies the relative central orbit of a pair of bodies attracting, according to the Newtonian law, but of variable mass. The investigation appears to be based on the assumption that the impressed force is equal to the product of the mass and acceleration, and not to the rate of change of momentum, the effect of variable mass thus being equivalent to a variation in the gravitational constant. The method would thus appear to be strictly applicable to the motion of two electrified bodies with variable charges, or attracting bodies parting with their substance by evaporation, but not to cases of bodies accumulating matter from without.

A RECENT number of *Scientia* contains an interesting article by Signor Aldo Mieli on Greek science and the characteristics of its development. He directs attention to the fact that while mathematicians hold in high esteem the achievements of Euclid and the investigations of Archimedes, and while the physician finds much to admire in the works attributed to Hippocrates, the chemist and the biologist are disposed to regard Greek speculation on their respective subjects as fruitless. These diverse judgments are due, he thinks, not to any different attitude of the Greek intellect towards one subject as compared with another, but rather to the special characters of the subjects themselves. The aim of Greek thought was the unification of disconnected knowledge. This laid the foundation of true science, but carried with it the tendency to reduce natural phenomena to a rigid geometrical or logical system. The culmination of Greek science was reached by Hippocrates, Aristotle, and Euclid. Hippocrates brought his generalisations to the test of observation; Aristotle in great measure did the same, the value of his results depending largely on the opportunities he possessed for checking them by observation and experiment. Euclid laid a solid foundation in the region of pure mathematics. The successors of the two former long delayed the progress of knowledge by an undue reliance on the dicta of their masters, but the "granitic" fabric of Euclid made possible the work of Apollonius on conic sections, and even the conception of the infinitesimal calculus reached by Archimedes.

MR. J. H. GARDNER, writing with reference to the note in NATURE of December 9 (p. 407) relating to the *Archives of Radiology and Electro-therapy*, in which the statement was made that "it is the only English periodical dealing with the subject of X-rays in all its bearings," reminds us that the Journal of the Röntgen Society, of which he is the editor, has for a much longer period dealt fully with this subject. The latter important and excellent journal, to which reference has frequently been made in NATURE, is, however, almost exclusively devoted to printing the Proceedings of the Röntgen Society, and therefore does not come within the same category as one dependent for its existence upon the conditions that apply to any other public periodical. For the same reason, we should not confuse the *Electrician*, or a new periodical on electrical engineering, with the Journal of the Institution of Electrical Engineers. This was the distinction we had in mind when referring to the new publication on radiology in all its branches.

UNDER the title *Archives Russes d'Anatomie, d'Histologie et d'Embryologie*, Prof. A. Dogiel, professor of anatomy and physiology in the University of Petrograd, has commenced the issue of a new periodical intended to make Russian workers in the three branches of biology embraced by it independent of German mediums of publication. All articles will be published in the Russian language, but they will be accompanied by translations into French or English, or summaries, which in no case will be less than three parts the length of the original paper. Three fascicules are to form a volume of about forty-five sheets of Russian text, illustrated by plates produced by the best engravers in Petrograd. The annual subscription will vary according to the number and nature of the plates, but will not exceed 12 roubles (25*s*.) for each fascicule. Subscriptions should be addressed to Prof. A. Dogiel, Pétrograde, Vasili Ostrov, 3e Ligne, Maison 4, logement 16, or to the publisher, K. Ricker, Pétrograde, Rue Morskaïa, 17.

OUR ASTRONOMICAL COLUMN.

COMET 1915*e* (TAYLOR).—This comet has been observed at the Naval Observatory, Washington, by Mr. H. E. Burton. On December 6, 11h. 33·5m., its position was R.A. 5h. 22m. 42·9s., declination 0° 1′ 36″, quite close to δ Orionis. Its magnitude is not stated.

SPECTROSCOPIC ORBIT OF 12 LACERTÆ.—Orbital elements have been obtained for this binary system by Mr. R. K. Young from a series of spectrograms secured at Ottawa. It presents technical difficulties owing to its extremely short period and faint magnitude. Its period remained in doubt until quite recently, and proved to be only 4h. 38m. 3s. The range of velocity is 35 km., the velocity of the system −14·23 km., the projected semi-major axis has the very small value =46600 km., and the mass function=0·0001. The spectrum is of type B2 (Crucian level). The system bears close resemblance to that of β Cephei.

THE USE OF THE BLINK-MICROSCOPE.—Further series of stellar proper motions found and measured by means of the blink-microscope are given in Circular No. 28 of the Union Observatory, South Africa. On twelve pairs of catalogue plates thirty-five stars with annual proper motions exceeding 0·1″ have been found. Of these seventeen were brighter than the 10th magnitude. Mr. Innes points out that observations of wide double stars justify the assumption that the vast majority of the stars on the plates is relatively "fixed" (*i.e.* moving as a group). Thus after picking out the proper-motion stars it would suffice for astrographic chart purposes to measure a mere dozen or so stars per plate, a proceeding which would cut down the vast programme of the Carte du Ciel Comité to 100,000 stars.

THE STRUCTURE OF THE SPECTRUM OF THE SOLAR CORONA.—The recent brilliant application of Planck's quantum theory to the explanation of some celestial spectra by Prof. J. W. Nicholson demonstrated that vibrations of a hypothetical dynamical system—the so-called protofluorine atom—should be capable of giving rise to the majority, but not all, of the then known lines in the spectrum of the solar corona. Among those not so picked up were three prominent lines, one of these being the well-known λ 5303, the others having wave-lengths 4359 and 3534 A. Prof. Nicholson stated that the cube-roots of the wave-lengths of these lines differed by a constant quantity,

a community of origin being thereby probably indicated. M. P. Carrasco now points out (*Comptes rendus*, vol. clxi., p. 631) that there is an additional member of this series, the next earlier term being the red line at λ 6374·2. This line, unknown when Prof. Nicholson was pursuing his investigations, was the most important feature of the coronal spectrum as photographed at the late eclipse (August 21, 1914), and M. Carrasco was one of the fortunate observers who obtained a record of the line.

AREAS OF ABSORPTION MARKINGS ON SECTROHELIOGRAMS.—The results of the limb prominence observations made at Kodaikanal Observatory during the first half of the current year are given in Bulletin No. 47. The mean daily area is the largest since 1908, and shows an increase of 59 per cent. over that for the preceding six months. Prominences seen projected on the disc as absorption markings on spectroheliograms taken in the light of the Hα reversal are being specially recorded with the grating spectroheliograph for measurement. Mean daily areas in millionths of the sun's visible hemisphere and mean daily numbers for the five half-years 1912–13, and January–June, 1915, are published in the above bulletin. For the second half of 1913 the areas were sixty, whilst for the first half of the present year they were 1375·6. The distribution in latitude of these markings shows the prominence maximum between 50° and 60°, together with a pronounced maximum about 30°, due to prominence in spot latitudes, the equator being avoided, as in the case of sun-spots.

THE CORROSION OF METALS.

ON December 8, under the presidency of Sir Robert Hadfield, the Faraday Society held a discussion on the corrosion of metals. Of the seven papers contributed, only two dealt with the more general aspects of this very important question. Three were concerned with the corrosion of iron, and some of the numerous steels which find application in modern industrial life; the remaining two had reference principally to marine condenser tube alloy, 70 : 30 brass. As it turned out, there was almost no discussion on the fundamental characteristics of corrosion phenomena. During the first hour instances of corrosion among iron alloys came under review, the remainder of the evening being devoted to a consideration of the corrosion of copper-zinc alloys.

As Dr. Rideal pointed out in his printed contribution to the more fundamental aspects of the question, "the phenomena observed in the corrosion of metals are to be found scattered among the earliest records of mankind, and in consequence of the universality of the subject we have received a heritage consisting of a jumble of facts and theories." The first report by Dr. Bengough to the Corrosion Committee of the Institute of Metals consists mainly of a critical examination of the views held with regard to the cause, or causes, of the corrosion of marine condenser tube alloy, the general conclusion being that the evidence is so conflicting that no particular view can be regarded as at all firmly established. The committee, therefore, in planning the experimental investigation decided that there was nothing for it but to begin at the very beginning and take nothing for granted.

Dr. Rideal's definition of corrosion is as follows:—"Corrosion may be said to result from an irreversible chemical change proceeding with a small velocity and taking place on the common surfaces between two or more phases, the products of which change are continually removed from the sphere of action." Moreover, it takes place generally on the surfaces of phases which are electrically conducting, a fact which lies at the base of the now generally accepted electrolytic theory of corrosion. This theory requires the presence of minute cells operating on the surface of the corroded metal or alloy. As yet, however, there is no information as to the number of such cells or the rate at which they work.

Dr. Desch's contribution dealt with the influence of physical and mechanical factors in corrosion, an aspect of the subject the importance of which is by no means always adequately realised. Although the process of corrosion is probably in all cases initially one of chemical solution, the physical heterogeneity of the metal or alloy has a considerable influence on its nature and velocity. More especially has this to be considered when it is remembered that many of the commonly used industrial alloys are in a "strained" condition, and contain, as Dr. Beilby has shown, films of amorphous material on the surfaces of slip of the crystals. Such films have been demonstrated to be more electropositive than the crystalline material, a fact which determines the course of corrosion of cold-worked metals in particular. The increased corrodibility of such alloys is no doubt also partly to be ascribed to the energy produced by work being stored up in these films.

The Cumberland process for preventing the corrosion of metals immersed in liquids, of which a demonstration was given at the close of the discussion, is based upon a recognition of the galvanic nature of this phenomenon. It consists in introducing a higher counter-electromotive force to that causing the corrosive action. A continuous current working at 10 volts is supplied to the anode, consisting of pieces of iron suspended in the liquid and insulated from the vessel being protected. It is claimed that this system has been in use in all types of steamships and in many large power plants, and that it is applicable to any metal in contact with water or any other corrosive liquid.

H. C. H. CARPENTER.

VISCOSITY OF OILS.

THE Institution of Petroleum Technologists is one of the most recent of our technological associations. Founded in 1913, to advance the study of mineral oils from the various points of view of the chemist, the geologist, the engineer, the prospector, and the financier, it has shown from the first a healthy vitality and the promise of a vigorous future. At a general meeting held on November 16, at the Royal Society of Arts, the institution had the pleasure of listening to an illuminating address by Dr. Glazebrook on the viscosity of oils in relation to the rate of flow through pipes. The tests described had been undertaken at the request of the Admiralty, and permission had been given for their publication. The results of the investigation showed that the ordinary law of viscous flow, $P/V=2\eta/9gd^2$, holds good in the particular case postulated so long as the critical velocity which is given in the expression $\rho Vd/\eta=2500$ is not exceeded.

Many experimental difficulties were met with in the actual measurements, which were carried out in the engineering department of the National Physical Laboratory by Mr. Pannell. The small variations in pressure were measured by means of a sensitive mercury tilting gauge, and the quantity of oil passed per minute through the pipes was measured on an Avery weighing machine. Thermal changes were eliminated by jacketing and careful electrical heating.

In general excellent agreement was found between the calculated and observed values of P/V through a wide temperature range.

Part ii. of the research was occupied with the determination of the physical contents of the various oils which were used. The densities call for little com-

ment, the change in density being proportional to the change in temperature. The viscosities were determined in the Redwood I. and II. instruments, from which absolute values can be obtained by means of the relationship $\eta/\rho = AT - B/T$, where A and B are calibration constants of the viscometer. The most marked observation in the viscosity results was the relatively enormous temperature coefficient exhibited by the Mexican fuel oils. Further, the results were shown to be dependent on the previous history of the oil. For example, an oil kept at 32° F. for six days showed an increase in viscosity at 60° F. amounting to 20 per cent., while a similar specimen, heated to 93° F. for the same period, exhibited a decrease of 11 per cent. This hysteresis effect was shown to have considerable practical importance in the handling and utilisation of such oils. The viscosity of mixtures of Mexican and shale oils was described; the viscosity-concentration curves are not linear, but are sagged, and thus it happens that a relatively small addition of shale oil to Mexican oil causes a considerable decrease in the viscosity. Careful tests were also made respecting the flash points of the oils, and their mixtures. The observation was made that a bulk sample of oil flashed somewhat lower than the small amount used in the Gray instrument. These experiments were carried out by Mr. W. F. Higgins.

Dr. Glazebrook concluded by pointing out that much work remained to be done in connection with the physics and chemistry of the mixtures of complex bodies which constitute fuel oils.

QUEENSLAND RAINFALL.[1]

MR. H. A. HUNT, the Commonwealth Meteorologist, has in previous reports given concise histories of the rainfall for New South Wales and Victoria, the volume under notice being thus the third of the series to be published. This report contains all the available annual totals and number of days with rainfall recorded to the end of the year 1913 for 1040 stations in Queensland, and in addition monthly values up to the end of 1912 are given for 137 stations, so distributed as to afford a good representation over the area under consideration. Many of the records go back to 1880, and even earlier, so that a good working basis is provided for investigators who require information in regard to local seasonal rainfall, or who may wish to compare the annual variations of rainfall in this part of Australia with those of the other States of the Commonwealth. Every effort was made to obtain trustworthy data, and in addition to the official records, all possible sources of information, such as histories of Queensland and old newspaper files, were searched. Much labour was involved in the elimination of discrepancies which so often appear when the same record is published in separate reports. A very useful appendix contains tables showing the monthly and yearly values of the meteorological elements (except wind direction and velocity) at Brisbane from 1887 to 1912.

The volume is copiously illustrated by maps and diagrams, among which may be mentioned twenty-seven annual rainfall maps covering the period 1887 to 1913, a map of mean annual rainfall, monthly normal rainfall maps, an *interim* rainfall map for Papua, and a frost map of Australia. Among the diagrams are several showing the height reached by various floods at the stations belonging to the hydrometric branch of the service, and graphs giving the mean annual rainfall of the whole State of Queensland and its sub-divisions. An interesting chronological history of remarkable atmospheric occurrences fills 96 pages of the report, the data being discussed back to the middle of last century. It is worthy of note that only four displays of the Aurora Australis are on record, the cases observed occurring in the years 1869, 1870, 1894, and 1909.

For the twenty-six years, 1888 to 1913, the mean annual rainfall for the whole State is 26·50 in., that of 1894, the wettest year, 40·39 in., and of 1902, the driest year, 12·63 in. The wettest year was thus 52 per cent. above the average, while the driest year showed a defect of the same amount. In the fourteen years, 1892 to 1905, only four exceeded the average, the disastrous effect of this long-continued drought being well shown in Diagram A, giving the total number of live stock, which fell from 27 millions in 1895 to 10 millions in 1902, the decline being checked in 1903 by a rainfall in excess of the normal.

The large average rainfall map which accompanies the report shows that the maximum rainfall, indicated by the isohyet of 160 in., is centred in the vicinity of Harvey Creek (lat. 17° S., long. 146° E.), and that for about 80 miles north and south of this point a rainfall exceeding 70 in. falls on the coast and for some distance inland. An annual rainfall of 70° in. is also found on the coast in four small patches located in latitudes 15° S., 21° S., 27° S., and 28° S. The smallest rainfall under 10 in. occurs in the west and south-west of the State south of 23° S.

It would have materially helped in the elucidation of the problems pertaining to rainfall distribution had the orographical features been indicated on this map. Queensland being in the monsoon region, the heaviest rains occur in summer, while the winter is usually quite dry.

The appearance in recent years of numerous memoirs dealing with Australian climatology is a marked tribute to the rapidly-growing activity and efficiency of the Commonwealth Service, the example of which in this respect will, we hope, be followed by other weather bureaux in the southern hemisphere.

R. C. M.

CHEMISTRY OF FIRE AND EXPLOSIVES.

IN a recent issue of the *Revue Scientifique* (September 25–October 9) Prof. A. Job has an interesting article upon the chemistry of fire and explosives. After considering the conditions for, and reactions during, ordinary combustion, the connection of explosion with combustion is described. It is pointed out that, in addition to the volume of gas evolved, heat developed, temperature attained, and pressure, another important factor remains, the rapidity of explosion. This leads to a distinction being drawn between explosives suitable for use as propellents, by reason of their progressive combustion, and what are termed in this country "high explosives," where the decomposition is initiated and propagated by shock (detonation). Mercury fulminate, nitrogen iodide, and lead azide are discussed as types of these sensitive detonating explosives. Fulminate is employed in detonators in France, lead azide being preferred in Germany, it being less sensitive to the decomposing action of moist heat.

As bursting charges for shells picric acid and trinitrotoluene are discussed, it being pointed out that whilst the former combines with metallic oxides, such as those of iron and lead, giving very sensitive compounds, and hence dangerous, the trinitrotoluene is free from this disadvantage. The higher melting

[1] Meteorology of Australia. Commonwealth Bureau of Meteorology. Results of Rainfall Observations made in Queensland, including all available Annual Rainfall Totals from 1040 Stations for all Years of Record up to 1913, together with Maps and Diagrams. Pp. 285. (Melbourne, 1914.) Price 10s. 6d.

point of picric acid (122°) than that of trinitrotoluene (82°) is another disadvantage, but this may be overcome by the use of certain eutectic mixtures. One such contains forty parts of picric acid with sixty parts of trinitrometacresol (*cresylite*). The mixture melts at 85°, and, after solidification, on reheating becomes plastic at 70°, which permits of compression to high density in the shell.

The various smokeless powders are dealt with, Vieille's work in the development of pure nitrocellulose powders receiving special mention. It is pointed out that, in addition to control of the rate of burning by variation in the form and size of the pieces, a greater proportion of the more slowly burning "soluble" nitrocellulose affords a means of control; thus for small arms the "soluble" may be 25 per cent., for large marine guns 50 per cent., the remainder being "insoluble" nitrocellulose.

Nobel's invention of the use of nitroglycerine as a non-volatile solvent is referred to as a great improvement, there being many disadvantages in the use of volatile solvents. A more recent non-volatile gelatiniser is dinitrotoluol, the Italian Avigliani powder being composed of "soluble" nitrocellulose fifty parts, "insoluble" N.C. twenty-five parts, dinitrotoluene twenty-five parts.

The use of stabilisers is next considered. It is shown that nitrocelluloses, like other nitric ethers, are liable to slow hydrolysis, with the formation of oxides and acids of nitrogen, these actions being promoted by moisture and rise of temperature, the rate being greatly increased by the catalytic action of the products. These actions lead to irregular ballistics, and even to spontaneous ignition. Stabilisers, of which diphenylamine is the most generally used (in ballistite, BN powder, etc.), absorb the liberated nitrogen compounds and prevent, or at least greatly retard, the decomposition.

In conclusion, particulars are given of the celebrated 75 mm. French gun. The projectile weighs 7·2 kilos., and has a muzzle velocity of 529 metres per second. The charge of powder B, in flake form, is 720 grams. It is shown that the gun, as a heat engine, gives an efficiency of 35·1 per cent. To an increase in this efficiency the author looks for further progress in the future.

THE MINUTE LIFE OF THE SEA.[1]

THE quantitative examination of the microplankton of the North European waters is the subject of the present important memoir, which is the outcome of a resolution of the International Council to take advantage of cruises in Denmark, England, Holland, Norway, and Sweden in the spring of 1912 for the collection of plankton samples taken by means of the water-bottle at depths ranging from 0 to 100 metres and more. In this way a series of accurately determined species is followed from sample to sample, and the distribution of these species is used to illustrate the laws of production and destruction of organic substance in the ocean. Prof. Gran has exhaustively examined the whole of the material collected with the exception of the greater part of the Scottish collections, for which Miss Ogilvie is responsible; a special chapter being devoted to this portion of the work. The samples were all preserved by adding Flemming's solution to the water directly it was collected. This method, although admittedly restricted, answers well for the preservation of all important Plankton species, as is shown by the fact that, when comparing the living material from Flødeveigen, Skager Rak, with the preserved, no species were found which were not present in the preserved material. For examination, Lohmann's centrifugal method is used, and the number of organisms (cells) per litre given in a series of tables with hydrographical data. Even delicate Peridiniales such as Gymnodinium, and Infusoria, especially Labœa, are well preserved, and are shown to form an important part in the economy of the sea.

Part i. gives a descriptive account of the plankton from each area taken separately. Of these the Danish results from the Skager Rak, taken both in February and in June, are of special interest. The colder surface water of the Skager Rak in February is found to contain an exceedingly rich Diatom plankton, which the author attributes not to the low temperature, but probably to the fact that the surface water is specially rich in some nutritive substance necessary to the development of the Diatoms. In June, this rich surface Diatom plankton has almost entirely disappeared, different species of Ceratium taking their place. The Danish water investigations also bring out striking results with regard to the relations existing between the assimilating algæ and oxygen tension in the different layers.

In Part ii. new light is thrown upon the distribution and biology of the separate species. *Nitzschia delicatissima*, Cleve, is found to be the commonest of all species in the plankton from the ocean round the Shetlands and the Faroes, having in places the large density of more than a million cells per litre. With regard especially to the Ceratium species, it is shown that passive sinking of the cells plays an important part in their vertical distribution, and this statement applies also to many of the other genera. The species of Labœa are true surface forms and are very abundant: "The whole of the ocean round Scotland and the Faroes contains, at the surface, on an average, one for each cubic centimetre of sea-water."

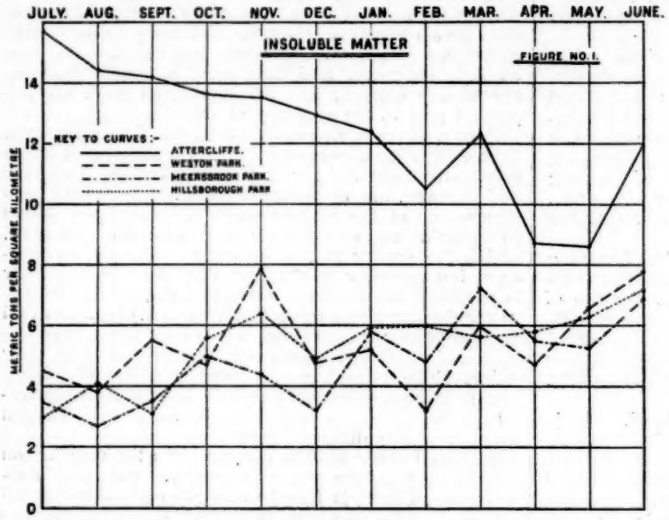
In the extensive discussion on general conditions of life and of plankton production, taking the many factors into account, the conclusion is arrived at that with the assimilating algæ the optimum production is near the surface, although the maximum at certain periods may be at a greater depth. Thus, in the case of the Ceratium species, although in the present investigations the greater number were found to occur at depths between 15–20 metres, it does not follow that this represents the depths of optimum production. In fact, other researches show it to be generally nearer the surface. The author suggests that by far the greater number of the assimilating plankton algæ have their maxima close to the surface, probably not as deep as 10 metres.

The last portion of the work on the horizontal quantitative variations of the plankton shows the influence of the coastal waters on distribution. The entirely different conditions of the area round Scotland and the Faroes compared with the Skager Rak and the north-eastern corner of the North Sea is thus explained by their supply on the one hand from Scotland and the Faroes, and on the other through the Baltic current from the Scandinavian coastal sea. Throughout the investigation runs the same idea binding the whole together and emphasising the importance of a permanent supply of nutritive substance from land. This nutritive substance taken up by the sea forms the means of subsistence of all plankton organisms which, originating from the coastal waters, spread out from thence into the more distant waters of the ocean. M. V. L.

[1] H. H. Gran: "The Plankton Production in the North European Water in the Spring of 1912." Conseil Permanent International pour l'explorations de la Mer. *Bulletin Planktonique* pour l'année 1912 (continuation du Bulletin Trimestriel des résultats acquis pendant les croisières périodiques et dans les périodes intermédiaires, Partie D). Publié par le Bureau du Conseil avec l'assistance de C. H. Ostenfeld, chargé du service planktonique.

ATMOSPHERIC POLLUTION.[1]

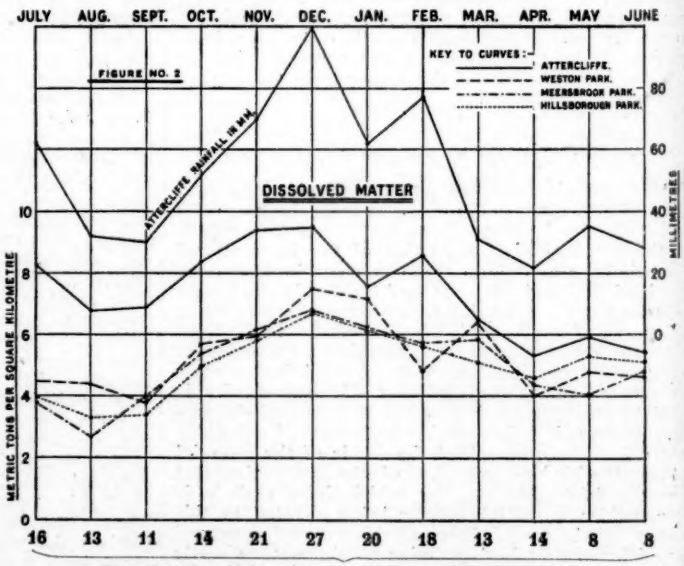
AS recorded in NATURE of December 17, 1914 (vol. xciv., p. 433), Sheffield is one of the cities joining in the observations on atmospheric pollution arranged by a committee representative of the Smoke Abatement Societies of the United Kingdom. The monthly results of the chemical examination of rain-water collected at four sites, approximately N., S., E., and W. of the Town Hall,[2] have been published in the *Lancet*, and are being embodied in the annual report of the medical officer of health of the city of Sheffield. The results do not accord with expectation, and certain conclusions have been reached which are perhaps of more than local interest, as they throw doubt on the value of chemical analyses of rain-water, either in the investigation of atmospheric pollution or in a comparison of the extent of pollution in different localities. It should be borne in mind that in Sheffield the distinction between factory and domestic smoke, which is based on the relative amounts of tarry matter and ammonia in the atmosphere (this journal, *loc. cit.*), cannot be drawn owing to the large number of reheating and annealing furnaces in operation in the east end (where the large steel works are situated), for which coal is burned so as to produce the smoke necessary for the metallurgical processes involved.



The curves, which show the total amount of insoluble matter (Fig. 1), and the total dissolved matter (Fig. 2) found in the rain-water collected at the end of each month, indicate for the three parks some deterioration of the atmosphere, as might be expected from the abnormal conditions arising out of the war. But the unmistakable evidence of diminishing pollution which the Attercliffe curves suggest, finds no support from what is known about the difficulties encountered in the east end with plant on war material contracts pushed to its utmost capacity, with fuel, and with the shortage of competent firemen, and it is in conflict with the sunshine records for Attercliffe, which show no improvement when compared with the average of the preceding ten years,[3] and with the number of warnings about excessive smoke emission issued by the smoke inspector, which show no decrease when compared with the average of the two preceding years.[4]

The total amount of each constituent determined in the rain-water collected at the four sites during the period July 1, 1914, to June 30, 1915, is set out in metric tons per square kilometre in the table:—

Site	Insoluble			Dissolved		Total solid matter	Sulphate (SO_4)	Chloride (Cl.)	Ammonia
	Tar	Combustible	Ash	Loss on Ignition	Ash				
Attercliffe	2·84	43·20	105·27	22·11	66·70	240·12	30·00	18·29	0·87
Hillsboro'	1·60	14·20	48·00	11·37	49·13	124·30	23·54	9·33	0·53
Meersbrook	1·68	14·78	41·07	12·96	46·83	117·32	24·02	9·36	0·53
Weston Park	2·15	15·40	47·55	17·01	46·92	129·03	25·23	9·14	0·53



No. of days in each month on which rain fell in Sheffield.

[1] Communicated in abstract to Section B (Chemistry) of the British Association, at Manchester, on September 9, 1915, and abridged from a Report made to the Health Committee of the Sheffield City Council in September, 1915, by Prof. W. P. Wynne, F.R.S. The whole of the chemical analyses were made by Mr Percy Hall-r, who was also responsible for the collection of the rain-water from the gauges.

[2] Attercliffe (Don valley), gauge approximately 2 miles E.N.E. of Town Hall and 148 ft. above sea-level; Hillsborough Park (Don valley), gauge approximately 2 miles N.N.W. of Town Hall and 250 ft. above sea-level; Meersbrook Park (Ruskin Museum), gauge approximately 2 miles S. of Town Hall and 362 ft. above sea-level; Weston Park (University), gauge approximately 1 mile W. of Town Hall and 425 ft. above sea-level. Each gauge was placed on the ground-level and at a sufficient distance from buildings to render the results comparative.

[3] Mr. E. Howarth, Curator of Weston Park Museum, has supplied the following information: Bright sunshine registered at Attercliffe during period July 1, 1914, to June 30, 1915, 1029 hours (average 1008 hours); at Weston Park, 1377 hours (average 1322 hours); at Bournemouth, 1791 hours (average 1740 hours).

[4] Warnings in 1912 and 1913 were 261 and 244 respectively, and in the period July 1, 1914, to June 30, 1915, they were 251.

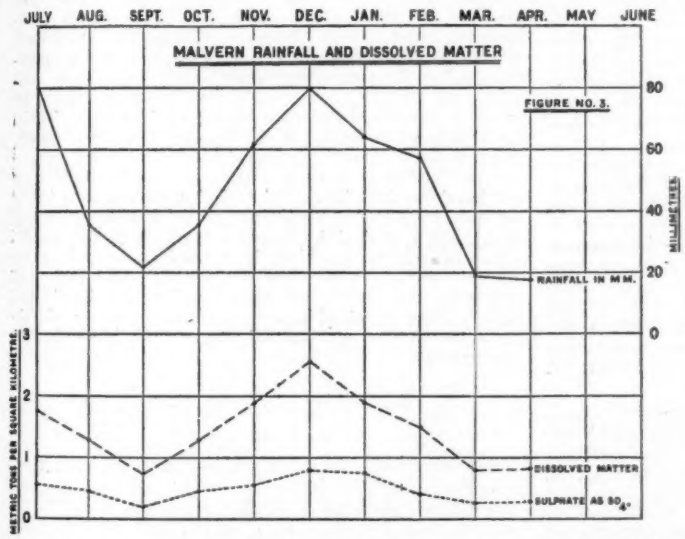
From these figures it will be seen that, while the amount of suspended combustible matter (carbon and tar) and mineral matter in the Attercliffe atmosphere is from 2·5 to 3 times as great as in that of the other districts, that of dissolved matter is not more than 1·5 times as great.

These figures furnish no clue to the amount of impurity in the atmosphere, except when rain is falling; nor is it clear to what extent allowance must be made for the amount of soluble matter dissolved by the same volume of rain when it falls in large drops and rapidly in one district but slowly and in a finely divided state in another. At the best, they represent a minimum value; they take no account of pollution during rainless periods, and to convey an approximate idea of the foulness of town atmospheres each monthly result would need to be multiplied by some factor derived from the proportion of rainless to rainy periods in the month. It is doubtful, therefore, whether a comparison of results obtained at different stations in the same observing area, or from different towns, under the Organising Committee's scheme of rain-water investigation, can have much value until something is known of the extent to which the data are dependent on the duration of the rain per month, or on the number of days on which rain was collected, or on the rate at which the rain came down, or on the direction and velocity of the wind during the dry and wet periods in the month.

Of all these influences which affect any scientific interpretation of the rain-water data, the only one that can be tested is the rainfall per month. To ascertain the influence which monthly variations in the rainfall may exercise on the amount of impurities washed out from the atmosphere by the falling rain, it is desirable to select the case of a town like Malvern, which is practically free from industrial smoke. As the pollution of Malvern's atmosphere may be assigned to one source—household fires—it might be expected to increase with the seasonal fall in temperature: to be greater in the winter than in the summer months. The figures (metric tons per square kilometre) for the period July 1, 1914, to April 30, 1915,[5] as published in the *Lancet* to the end of September, 1915, are given in the following table:—

	July	Aug.	Sept.	Oct.	Nov.	Dec	Jan.	Feb.	Mar.	April
Tar . . .	0·01	0·01	0·01	nil.	0·01	0·01	trace	—	—	0·01
Insoluble matter	0·71	0·71	0·81	0·42	0·46	0·84	0·12	0·25	0·21	0·27
Dissolved . .	1·76	1·30	0·72	1·29	1·02	2·54	1·93	1·47	0·81	0·80
Total solids	2·47	2·01	1·53	1·72	2·38	3·39	2·06	1·72	1·02	1·07
Sulphate (SO_4) .	0·56	0·47	0·18	0·43	0·53	0·79	0·74	0·41	0·28	0·25
Chlorine (Cl) .	0·35	0·13	0·12	0·19	0·36	0·56	0·24	0·41	0·10	0·11
Ammonia . .	0·05	0·03	0·00	0·02	0·0.	0·02	0·01	0·01	0·01	0·12
Rainfall in mm.	80	36	22	36	61	80	64	37	19	17

While the figures recorded for insoluble matter, including tar, are not easy to interpret, those for dissolved solids and for sulphate seem at first sight to indicate an increase in pollution with the advent of winter. But they bear another complexion when plotted against the measured monthly rainfall, as will be clear from an inspection of diagram No. 3, and the criticism may be ventured that, for a town like Malvern, the Organising Committee's scheme of chemical investigation might serve better as a means of recording variations in rainfall than as a method for determining the extent of variation of atmospheric pollution. Nor is this criticism disarmed in the case of a manufacturing town like Sheffield, in which atmospheric pollution is due partly to industrial smoke—fairly constant in amount all the year round—and to domestic smoke, varying in amount according to the season, for when a comparison is made of the curves for the rainfall and for the dissolved solids and the sulphate, a similar correspondence in shape can be traced. As an illustration, the Attercliffe rainfall curve is shown in Fig. 2 above the curve for dissolved matter for the same district.



It seems probable that the chemical investigation of atmospheric pollution by the rain-water method could give comparative results only if rain fell at a unform rate, and either all day or at the same period of each day, conditions not attainable in nature. Notoriously, Sheffield's atmosphere is at its worst on a calm day; there were many days during last winter when the University building, 250 ft. above the Don valley, was enveloped in a smoke fog, but as no rain fell the pollution of the atmosphere, so evident to the senses, found no record in the chemical analyses of the rain-water collected on other days than these. Better results might be obtained if a feasible method could be devised for drawing air continuously and at a given rate through water, but whether their value, as evidence of atmospheric pollution, would be commensurate with the cost is a question which experiment alone could decide. If the British Association could see its way to appoint a committee to investigate the comparative merits of chemical and physical methods of studying atmospheric pollution,[6] new processes might be devised which would furnish evidence of avoidable pollution (the main object of the inquiry into the smoke nuisance) more readily and at less cost than the chemical analysis of water used to wash impurity out of the air.

[5] The Malvern results for May and June, which have since been published (*Lancet*, October 9, p. 822; November 6, p. 1046), support the conclusions drawn from the earlier data.

[6] Since this paper was read, a committee of the British Association has been appointed to report on "Fuel Economy and Smoke Abatement" (see p. 205.)

Subject to the limitations imposed on any comparative treatment of the results recorded for the towns which have taken part in the inquiry, it may be of interest to point out that, after allowances have been made for differences in rainfall, Sheffield, according to the analytical data published in the *Lancet*, is a less smoky city than Manchester. This conclusion follows from a comparison of the figures for the six stations, N., E., and S., situated within three miles of Manchester Town Hall (Salford, on the west, did not take part in the inquiry), with those for the four stations, roughly, N., E., S., and W., situated within two miles of the Sheffield Town Hall. How far such evidence justifies the conclusion that Manchester chimneys pour into its atmosphere a correspondingly larger amount of impurity is doubtful; the contour of the land as promoting or retarding the dispersal of smoke is one of many factors to be taken into account before a definite opinion should be hazarded, and no two towns could differ more than Manchester and Sheffield in this respect.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

IT is stated in the issue of *Science* for November 26 that approximately 200,000*l.* is to go to Yale University under the will of the late Mr. Justus S. Hotchkiss, of New Haven. The trust fund thus established is to be shared equally among the academic, law, and theological departments.

THE Cambridge University Press has published "The Book of Matriculations and Degrees: a Catalogue of those who have been matriculated or admitted to any Degree in the University of Cambridge from 1901 to 1912." With the present volume the period covered, so far as a record of degrees is concerned, is from 1544 to 1912. Honorary titles of degrees conferred from 1901 to 1912 are included. The catalogue has been prepared for the press by Mr. B. Benham, the assistant registrary, and Mr. C. J. Stonebridge, the registrary's clerk. The price of the volume is 12*s.* 6*d.* net.

DR. JOHN READ, lecturer and demonstrator in chemistry in the University of Cambridge, has been elected to the chair of organic chemistry—pure and applied—in the University of Sydney, in succession to Prof. R. Robinson, lately appointed to the chair of organic chemistry at Liverpool. Dr. Read was educated at Sexey's School, Bruton, Somerset, passed through the Finsbury Technical College, under Prof. R. Meldola, in 1901–1904, was at Zürich with Prof. Alfred Werner, 1905–7, and has since been associated with Prof. W. J. Pope at Manchester and Cambridge, having published in collaboration with him a considerable number of papers of stereochemical interest.

THE sixteenth annual meeting of the Association of Public School Science Masters will be held on January 4 and 5, under the presidency of Sir William Osler, who will open the proceedings with an address entitled "The Fateful Years, 1915–1917," in which he will make a plea for earlier and more intensive work in science subjects so as to save time at the universities. The programme also includes the following papers and subjects for discussion:—"Desirability of Giving a Bias towards Agriculture in the Science Teaching in Schools," C. Turnor; "School Museums," M. D. Hill; "War-Work in Schools," S. J. Hough; "The Extent to which it is Desirable to Modify the Teaching of Science in Schools to Meet the Requirements of War," C. L. Bryant.

DR. E. FOX NICHOLS has resigned the presidency of Dartmouth College, New Hampshire, which he has held since 1909, in order to accept an invitation to a chair of physics at Yale. In his letter to the Dartmouth trustees he explains that the special needs of the college which led him to accept the headship have now been largely met, and that there seems therefore no compelling reason why he should not go back to his earlier work, the duties and recompenses of which are in fuller accord with his individual taste and preference. The incident has aroused a good deal of favourable comment in the American Press, as indicating a break in the general tendency, in American academic circles, to prefer the attractions of an administrative post to the claims of scientific research and teaching.

THE approaching retirement of Dr. William Garnett from the post of educational adviser to the London County Council demands some grateful reference to years of work that have left a permanent mark upon London education. A student of the Royal School of Mines and a Whitworth scholar, a fellow of St. John's and first demonstrator under Clerk Maxwell in the Cavendish Laboratory, Dr. Garnett illustrated in his training the happy union between pure and applied science upon which the well-being, and even the security, of our national life depend. His principalship of the Durham College of Science showed how clearly he had grasped the essential principles of technical education; his opportunity of applying those principles on a large scale came with his appointment, in 1893, as secretary and educational adviser to the Technical Education Board of the London County Council. The eleven years of the board's activity must always be regarded as of momentous importance in the history of London education. Polytechnics sprang into being or were revivified, a clearly conceived system of central and local technical institutes materialised, the conditions of science teaching in secondary schools were enormously improved, and the scientific and technical work of the University was greatly stimulated and aided. The hand of Dr. Garnett was plainly visible in all these good works, and they will be his enduring monument.

SOCIETIES AND ACADEMIES.

LONDON.

Physical Society, November 26.—Dr. A. Russell, vice-president, in the chair.—J. **Guild**: Obtaining and maintaining a bright hydrogen spectrum, with special reference to the 4341 line. The paper treats of the conditions of pressure, discharge, etc., most suitable for the production of a bright hydrogen spectrum, such as is required for refractometry and similar purposes. The rapid deterioration of the tubes with use is shown to be caused by a rise of pressure due to the evolution of hydrogen by the electrodes. The trouble may be obviated by sealing an auxiliary bulb of 1½ or 2 litres capacity to the discharge tube. This reduces the rate of pressure variation and prolongs the useful life of the tube nearly a hundredfold. The use of capacity and inductance is shown to be very helpful with partially deteriorated tubes.—A. **Griffiths**, J. M. **Dickson**, and C. H. **Griffiths**: The determination of the coefficient of diffusion of potassium chloride by an analytical method. This paper represents an attempt to develop an analytical method of determining the coefficient of diffusion of a salt in water capable of giving consistent and accurate results. The lower ends of a number of vertical and parallel diffusion tubes terminate in a reservoir of large capacity containing a solution of potassium chloride. The greater part of the reservoir is above the lower ends of the tubes, and by gravity the solution at the lower ends is kept at an approximately constant concentration. The upper

ends of the tubes are covered with a cap provided with an outlet and an inlet tube. Water enters the cap by the inlet tube, and a weak solution containing the diffused salt leaves the cap by the outlet tube. Time, which may be as long as a fortnight, is allowed for the attainment of the steady state, and an individual experiment may last six weeks. The quantity diffused is obtained by chemical analysis. In the case of a solution containing 0·2237 gram of potassium chloride to the cubic centimetre (a 3N solution) the "mean diffusivity" with respect to water is $1{\cdot}703 \times 10^{-5}$ (C.G.S. units) at a temperature of 18·5° C.

Royal Astronomical Society, December 10.—Prof. R. A. Sampson, president, in the chair.—H. H. **Turner** and Miss **Blagg**: Baxendell's observations of variable stars; continuation, including T Herculis, R Leonis, and S Orionis.—F. A. **Bellamy**: The number of faint stars with large proper motions in zone +29°, and on the accuracy of Hagen's chart of variable stars.—H. H. **Turner**: Ninth note on the astrographic magnitude scales: the Toulouse and Cape magnitudes, with further remarks on the obscured patch in the sky, considered as a spiral. The data for the southern hemisphere were unfortunately very incomplete, as there is a gap in the observations between −1° and −31°.—J. H. **Jeans**: The theory of star-streaming and the structure of the universe. Various hypotheses were considered, and it was concluded there is no hope of unravelling the mechanism of the universe by assuming that it is in a steady state, or of using the observed phenomena of star-streaming for exploring its structure.—J. H. **Reynolds**: Photographs of Jupiter, taken in November with the 28-in. reflector.—G. E. **Hale**: Spectroheliographs of a remarkable disturbed region of the sun, August 7, taken at the Mount Wilson Solar Observatory, California.—W. H. **Wright**: Series of photographs of the spectra of nebulæ taken at the Lick Observatory. It was hoped that they would assist in a proper classification of nebulæ by their bright-line spectrum. The nuclei of most nebulæ stood high on the temperature scale, and red stars are not associated with nebulæ. An important circumstance was the appearance in the spectra of lines of carbon and nitrogen.—H. C. **Plummer**: The distribution of stars in globular clusters; and on the motions and distances of the bright stars of type F. In the latter investigation the author was greatly assisted by a table of stellar motions in equatorial co-ordinates, and other data, for stars of type F, by Mr. O. R. Walkey.

CAMBRIDGE.

Philosophical Society, November 22.—Prof. Newall, president, in the chair.—Prof. **Hughes**: Notes on oysters, recent and fossil. The author exhibited and described a large collection of recent and fossil oysters, pointing out how the modification of shape to suit changing conditions, as observed in recent specimens, suggested explanations of the evolution of species, in accordance with environment, among similar fossil forms.—Dr. **Marr**: Fossil zones and geological time. An attempt is made to estimate the time required for the accumulation of the fossiliferous rocks by taking the case of the chalk, comparing its rate of accumulation with that of the modern globigerinous ooze, and then calculating the number of fossil-zones in the chalk and in the whole of the fossiliferous strata. The result obtained suggests a minimum period of not fewer than 21,000,000 years for the formation of the fossiliferous strata. The controlling factors are too uncertain to permit much stress to be laid on this estimate, which is probably much too low, but according to it the evolution of organisms from the beginning of Cambrian times onwards need not have occupied a period of time greater than that which on various grounds is granted to geologists by followers of other sciences. The method may be applied with nearer approximation to accuracy, in estimating the relative importance of different groups of strata; thus the number of zones in Palæozoic and Mesozoic rocks respectively indicates that the period during which the former were being laid down was not necessarily much longer than that required for the accumulation of the latter.—H. B. **Fantham** and Miss Annie **Porter**: Induced herpetomoniasis in birds. All the great classes of European vertebrates, except birds, have been infected by the authors previously with flagellates found in various insects. Results are now given of some experiments in which birds have been similarly infected. Herpetomoniasis can be induced in birds, for example, canaries (*Serinus canarius*), sparrows (*Passer domesticus*), and martins (*Chelidon urbica*) by feeding them on insects containing herpetomonads, or on food contaminated with insect fæces containing herpetomonads. *Herpetomonas culicis* from the gnat, *Culex pipiens*, and *H. jaculum* from *Nepa cinerea*, have fatally infected birds when fed to them. Both flagellate and non-flagellate herpetomonads have been found in the internal organs of the infected hosts. The cycle of the flagellates in the avian hosts resembled that in the insects. Members of all classes of vertebrates may be capable of acting as reservoirs of herpetomoniasis, and the virus may exist in a very attenuated condition and so be difficult of detection.—H. B. **Fantham** and Miss Annie **Porter**: Notes on certain Protozoa which may be found in cases of dysentery from the Mediterranean war zone. The authors dealt briefly with the morphology and life-histories of *Entamoeba histolytica, E. coli, Trichomonas hominis, Chilomastix* (*Tetramitus*) *mesnili, Giardia* (*Lamblia*) *intestinalis* and *Balantidium coli*. The pathogenic actions of these parasites were discussed. Various preventive measures, the occurrence of carriers and of reservoirs were indicated. The modes of treatment successfully used by recent workers were mentioned.—Dr. **Arber**: A little-known concealed coalfield in Oxfordshire. The results of the Burford and Batsford borings appear to show that, in this concealed coalfield, the Coal Measures are red-grey productives, probably belonging to the Transition Coal Measures. These beds overlie Silurian rocks. The measures appear to be related to those of the Newent and Wyre Forest Coalfields, both lithologically and as regards horizon.

PARIS.

Academy of Sciences, November 29.—M. Ed. Perrier in the chair.—The President announced the death of Charles René Zeiller.—Maurice **Hamy**: The determination of radial velocities with the prism objective. In a preceding communication a method was sketched for the determination of the radial velocities of stars, making use of a prism objective. Detailed calculations are now given.—H. **Douvillé**: The Orbitoids: their development and embryonic phase. Their evolution during the Cretaceous period.—M. de **Séguier**: The equations of certain linear groups in a Galois field.—M. **Pigeaud**: The elastic equilibrium of an indefinite plate of uniform thickness, compressed by two equal and opposite forces, uniformly distributed along two parallel right lines situated in a plane normal to the bases.—Œchsner **de Coninck** and **Gerard**: The atomic weight of cadmium. Details of the method employed for the purification of the commercial cadmium are given. The experimental ratio determined was cadmium oxide from cadmium carbonate, and the mean of five determinations was 112·32, as against the atomic weight adopted by the International Commission, 112·40.—O. **Bailly**: The mechanism of the action of the tribasic sodium phosphate on the α-mono-

chlorohydrin of glycerol.—E. A. **Martel**: The contamination of subterranean waters as a consequence of the war. An example is given of contamination of a water supply persisting for a whole year, and the necessity of special precautions in maintaining the purity of potable water is pointed out. It must not be taken for granted that after a certain lapse of time processes of self-purification are sufficient.—J. **Bergonié**: A new method of surgical radioscopy in red light.—A. **Renault, L. Fournier,** and L. **Guénot**: Five hundred and fifty cases of syphilis treated by an organic compound of arsenic, silver bromide, and antimonyl. Further experiments on treatment of syphilis with the compound proposed by M. Danysz under the name of "102." It has the special advantage that there is a wide range between the parasitic dose and the toxic dose. The therapeutic effects are comparable with those of arseno-benzene. The preparation possesses great stability, the treatment is simple and without danger, and extremely efficacious.

BOOKS RECEIVED.

A Text-Book of Inorganic Chemistry. Edited by Dr. J. Newton Friend. Vol. viii.: The Halogens and their Allies. By Dr. G. Martin and E. A. Doncaster. Pp xviii+337. (London: C. Griffin and Co., Ltd.) 10*s*. 6*d*. net.

The British Warblers. By H. E. Howard. Two vols. (London: R. H. Porter.) 10*l*. 10*s*. net.

The Book of Matriculations and Degrees. Pp. xvi+315. (Cambridge: At the University Press.) 12*s*. 6*d*. net.

Memoirs of the Queensland Museum. Vol. iv. Edited by Dr. R. Hamlyn-Harris. Pp. 365. (Brisbane: A. J. Cumming.)

Submarines: their Mechanism and Operation. By F. A. Talbot. Pp. x+274. (London: W. Heinemann.) 3*s*. 6*d*. net.

Archaic Sculpturings. By L. M. Mann. Pp. 52. (Edinburgh and London: W. Hodge and Co.) 2*s*. 6*d*. net.

Roald Amundsen's Antarctic Expedition. Scientific Results: Meteorology. By H. Mohn. Pp. 78. (Kristiania: H. J. Dybwad.)

Rural Sanitation in the Tropics. By Dr. M. Watson. Pp. xvi+320. (London: J. Murray.) 12*s*. net.

Ticks. Part ii., Bibliography of the Ixodoidea II. By Prof. G. H. F. Nuttall and L. E. Robinson. Pp. 32. Part iii., The Genus Hæmaphysalis. By Prof. G. H. F. Nuttall and C. Warburton. Pp. xiii+349–550+plates viii–xiii. (Cambridge: At the University Press.) 4*s*. 6*d*. net and 12*s*. net respectively.

Carnegie Endowment for International Peace. Year Book for 1915. Pp. xvii+177. (Washington, D.C.)

My Growing Garden. By J. H. McFarland. Pp. xiii+216. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd.) 8*s*. 6*d*. net.

Transactions of the Royal Society of Edinburgh. Vol. li. Part i. (No. 4): The Temperatures, Specific Gravities, and Salinities of the Weddell Sea and of the North and South Atlantic Ocean. By Dr. W. S. Bruce, A. King, and D. W. Wilton. Pp. 71–169. (Edinburgh: R. Grant and Son; London: Williams and Norgate.) 8*s*. 3*d*.

A Manual of Soil Physics. By Prof. P. B. Barker and H. J. Young. Pp. vi+101. (Boston and London: Ginn and Co.) 3*s*.

A Treatise on the Theory of Invariants. By Prof. O. E. Glenn. Pp. x+245. (Boston and London: Ginn and Co.) 10*s*. 6*d*. net.

A Voyage in Space. By Prof. H. H. Turner. Pp. xvi+304. (London: S.P.C.K.) 6*s*. net.

DIARY OF SOCIETIES.

THURSDAY, DECEMBER 16.

ROYAL SOCIETY OF ARTS, at 4.30.—The Indian Jute Industry: C. C. McLeod.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—The Design of High-pressure Distribution Systems: J. R. Beard.

ROYAL GEOGRAPHICAL SOCIETY, at 5.—The Nature and Formation of Sand Ripples and Dunes: W. J. Harding King.

LINNEAN SOCIETY, at 5.—The Structure and History of Play: The Floating Fen of the Delta of the Danube: Miss Marietta Pallis.—The Seed-mass and Dispersal of *Helleborus fœtidus*, Linn.: T. A. Dymes.—Sample of "Figured Ebony," with Specimens of Walking-sticks Manufactured from it: B. Daydon Jackson.—The Reproduction of Protodrilus: E. S. Goodrich.

INSTITUTION OF MINING AND METALLURGY, at 8.—Influence of Heat in Cyaniding Gold Ores: E. A. Wraight.—Clay: Its Relation to Ore Dressing and Cyaniding Operations: A. W. Allen.—Wolframite Mining in the Tavoy District, Lower Burma: E. Maxwell-Lefroy.

FRIDAY, DECEMBER 17.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Engineering Colleges and the War: Dr. R. Mullineux Walmsley and C. E. Larard.

MONDAY, DECEMBER 20.

ARISTOTELIAN SOCIETY, at 8.—The Common-sense Criterion of Reality: J. W. Scott.

TUESDAY, DECEMBER 21.

INSTITUTION OF PETROLEUM TECHNOLOGISTS, at 8.—The Uralsk Province and its Oilfields: F. A. Holiday.

ROYAL STATISTICAL SOCIETY, at 5.15.

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